REPORT

of STSM from 26.02. till 05.03.2017 (8 days) by Dr. Ivan Sopushynskyy

completed at

Poznań University of Life Sciences, Faculty of Forestry,

Department of Forest Utilisation

The objective of the Short Term Scientific Missions (STSM)

The main objective of the STSM was to find out productivity and costs of harvester and chainsaw thinning operations on four natural alder coppice stands (720 trees/ha) on the area of 2 ha in the North of Poland.

Description of work

As planned, the STSM started on February 25, 2017 and finished on March 5, 2017 (8 days) including 2 days of travelling. The study work started on February 26, 2017 and finished March 4, 2017 (6 days). The study was carried out in the 47-year-old alder coppice stands (wet site conditions), in the Forest District Zaporowo, Northern Poland (Figure 1).

Figure 1. Location of alder coppice stands

The natural alder coppice stands were divided in four sample areas: № 3, 4, 5, 6 to study productivity and costs of harvester and chainsaw operations (Figure 2).

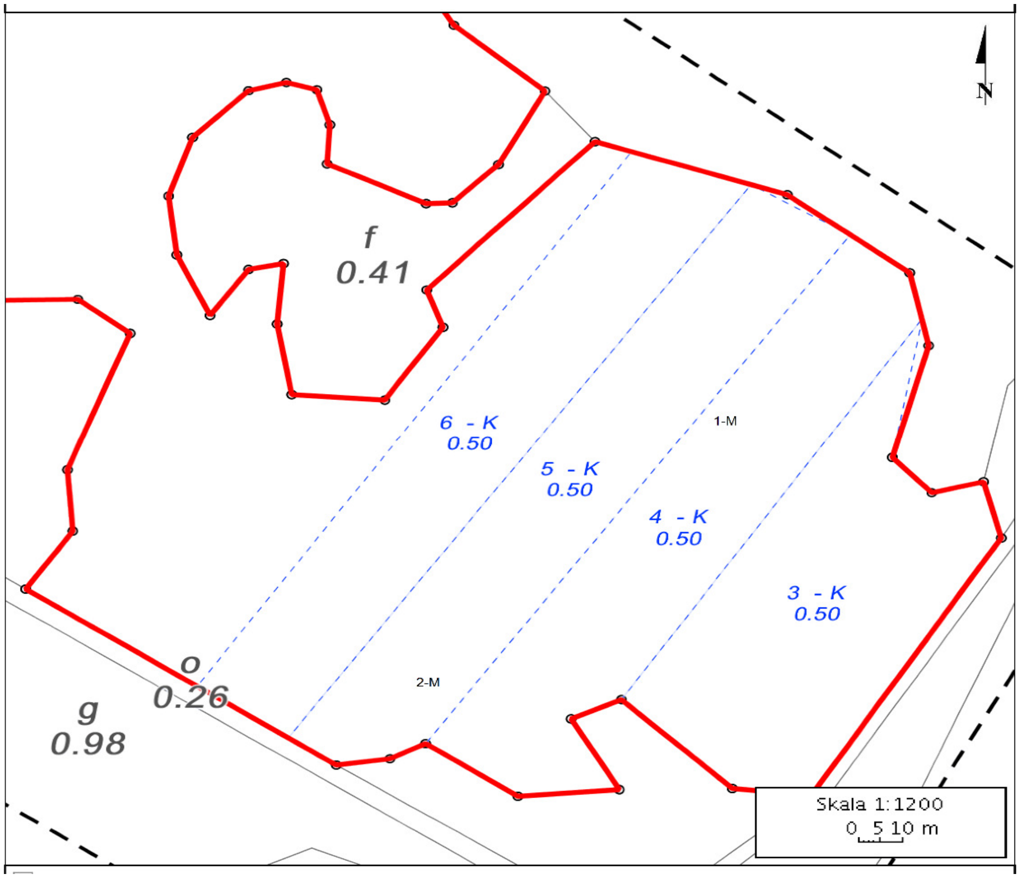

Figure 2. Selected sample plots of alder coppice stands

Areas №1-M and №2-M were given to the small mires (Figure 3).

Area №1-M *Area №2-M*

Figure 3. Mires in alder coppice stands

Silvicultural and dendrometrical characteristics of alder coppice stands (Figure 4) were collected on four studied alder coppice stands per 0.5 ha and per 360 trees/ha that are presented in the Table 1.

Sample area №3 *Sample area №4*

Sample area №5 *Sample area №6*

Figure 4. Nature alder coppice stands

At the first stage, the study work was directed to measure the following silvicultural and dendrometrical characteristics of alder coppice stands: $N_{treegr.}$ – number of trees groups; h_{tree} – height of tree [m]; $h_{spr.crown}$ – spring of crown [m]; $d_{1.3m}$ – diameter at the breast height [cm] (Table 1).

Table 1

Silvicultural and dendrometrical characteristics of alder coppice stands

Characteristics	$N_{treegr.}$	N_{trees}	$d_{1.3m}$ **[cm]**	h_{tree-}**[m]**	$h_{spr.crown}$ **]m]**
Sample area №3	34	358	17	15,1	6,9
Sample area №4	44	351	20	17,3	7,6
Sample area №5	40	360	20	17,3	7,2
Sample area №6	39	369	18	16,0	5,9

The mean diameter at breath height in sample areas №3-6 varied from 17 to 20 cm and the tree heights - from 15,1 to 17.3 m. It was decided that two areas №4 and №5 will be operated by harvester Preuss 84 V.II 6WD produced 2007 with Crane Waratah 9,7 m and Head Kesla 20RH (Figure 5) and other two areas №3 and №6 - by chainsaw Stihl MS 362 (Figure 6). On all sample areas of alder coppice stands, the same types of assortments of the pulpwood of 2.5 m in the length were produced by harvester and chainsaw operations.

Figure 5. Preuss 84 V.II

Figure 6. Chainsaw Stihl MS 362

The smaller diameter of merchantable timbers (pulp wood) without bark were at least 5 cm. Time studies were carried out with respect to the productive machine hour (PMH) without delays (Mederski et al. 2016). Time studies data were collected by means of a hand-held chronometer and especially designed data collection forms. Each tree was stopwatched individually, using a smartphone chronometer. Operational time considered time elements move, fell and process.

The second stage of the research work was focused on the estimation of the following variables: V_{tree} – volume of growing tree [m^3]; M_{tree} – total volume of growing trees [m^3]; $d_{assort.}$ – top diameter of the last assortments [cm]; $l_{assort.}$ – total length from one tree [m]; P – percentage of total length of assortments from the tree height [%]; $d_{assort.middle}$ – middle diameter of assortments [cm]; $V_{av.assort.}$ – average volume of assortments [m^3] (Table 2).

Table 2

Main volumetric characteristics of trees and pulpwood

Characteristics	V_{tree} [m^3]	M_{tree} [m^3]	$d_{assort.}$ [cm]	$l_{assort.}$ [m]	$P_{length/height}$ [%]	$d_{assort.middle}$ [cm]	$V_{av.assort.}$ [m^3]
Sample area №3	0,1328	47,6	7,3	10,7	70	10	0,0877
Sample area №4	0,2086	73,2	7,1	12,4	72	11	0,1249
Sample area №5	0,1986	71,5	7,4	12,4	71	11	0,1246
Sample area №6	0,1466	54,1	8,1	11,7	73	10	0,1061

The average volume of assortments varied from 0.0877 m^3 to 0.1246 m^3 and the similar value was characterized by sample areas №4-5 that were operated by harvester.

The third stage of the research work was focused on the estimation of the following variables: $t_{oper.}$ – operational time *including rest, maintenance, filling tank etc.* [s]; σ_m **- s**tandard Error of mean; $C_{fix.}$ and $C_{ver.}$– fixed and variable costs of contractors of one tree [Euro]; $V_{timbers}$ – total volume of harvested timbers [m^3]; T – total amount of work hours [hours] and P – productivity per machine or per person [$m^3 \cdot h^{-1}$] (Table 3). Productivity (P) was calculated as: $P=V/T_{PMH}$, where: V –volume of harvested timber, m^3; T_{PMH} – time of productive machine hour (moving, crane and head positioning, cutting, felling, delimbing and bucking; without delays), h.

Table 3

Variables of productivity and costs of harvester and chainsaw operations

Characteristics	$t_{oper.}$ **[s]**	$\sigma_{mtoper.}$	$C_{fix.}$ **[Euro]**	$\sigma_{mCfix.}$	$C_{ver.}$ **[Euro]**	$\sigma_{mCver.}$	$V_{timbers}$ **[m^3]**	**T [hours]**	**P** [$m^3 \cdot h^{-1}$]
Sample area №3 (chainsaw)	322	122,50	0,09	0,0127	0,56	0,0815	31,38	32	0,98
Sample area №4 (harvester)	42	15,31	0,31	0,0141	0,62	0,0284	43,85	4,12	10,64
Sample area №5 (harvester)	42	15,85	0,31	0,0135	0,62	0,0270	44,85	4,24	10,58
Sample area №6 (chainsaw)	351	144,40	0,10	0,0117	0,69	0,0843	39,14	36	1,09

Notably that the productivity of harvester in the areas with similar dendrometrical features was characterized by similar value in the alder coppice stands.

Results

The results show a difference of the operational time by chainsaw and harvester Figure 7.

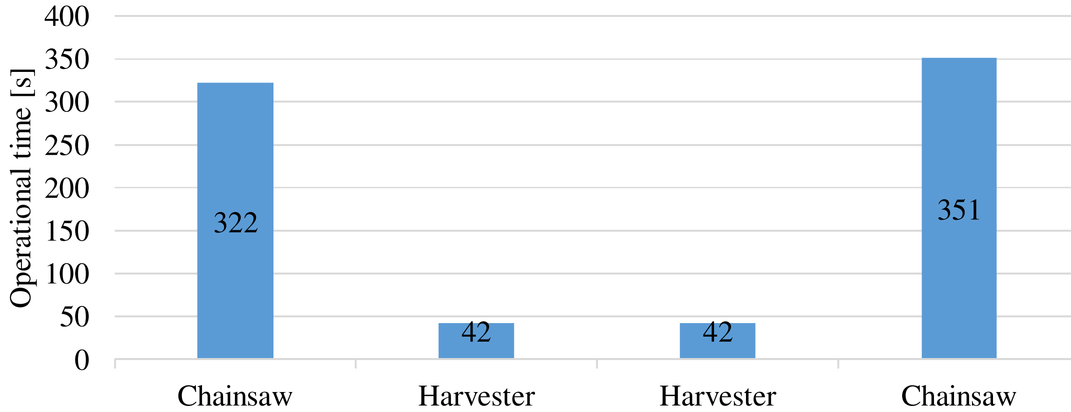

Figure 7 Operational time of chainsaw and harvester in alder coppice stands

The harvester needed in the average 42 s for one tree comparing to the chainsaw it is 8 times less. The less value of fixed and variable cost were characterized by chainsaw operations (Figure 8)

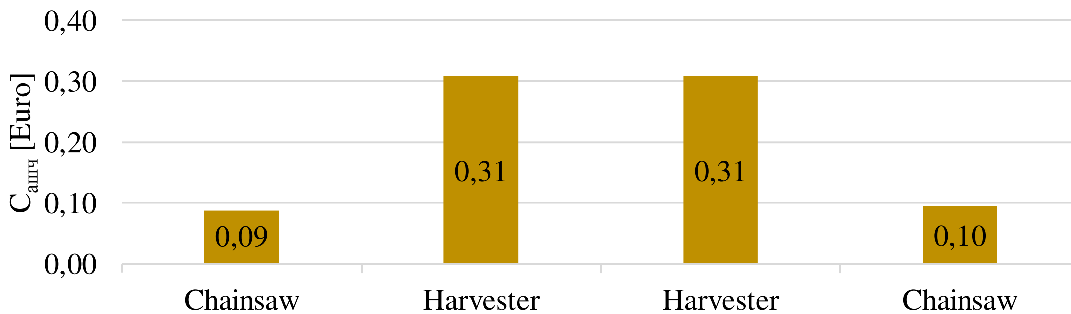

Figure 8 Cost by the chainsaw and harvester operations

The fixed cost of chainsaw was estimated in the value of 0.09…0.10 Euro/tree and for the harvester – in the value of 0.31 Euro/tree.

The results showed a wide range of productivity rates between harvester and chainsaw operations (Figure 9).

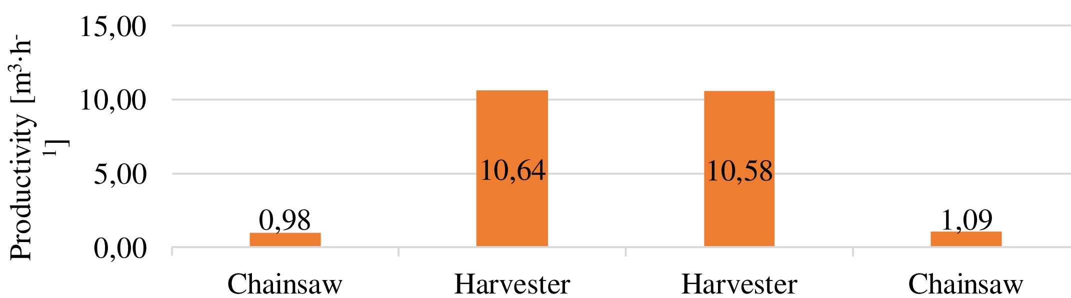

Figure 9 Productivity of chainsaw and harvester in alder coppice stands

The harvester productivity ranged from 10.58 $m^3 \cdot h^{-1}$ to 10.64 $m^3 \cdot h^{-1}$ and the chainsaw productivity - from 0.98 $m^3 \cdot h^{-1}$ to 1.09 $m^3 \cdot h^{-1}$.

Summarizing the research results, it should be noted that the cost efficiency is less by the chainsaw operations at alder coppice stands, but if we would like to take into account the time efficiency, it is better to use harvester. To discuss about the most cost effective method, we need to know, what the investment in two different methods of operations is? In the chainsaw operation the total investment is about 5000 Euro (chainsaw and uniforms) and in the harvester – about 200 000 Euro respectively. To get real point of the most effective methods, which methods of operations are preferable, it is important to have the whole area of coppice stands in the region or regions and the distance between the separate coppice areas and then to make effective planning. It is an objective of the next scientific project that we have planned. All planned data were recorded to continue the similar research at Ukrainian alder coppice stands.

The conclusion of the STSM study is that the most profitable method is the use of harvester in this particular case – at alder coppice stands, because the high productivity and the small operational time as well as the wood harvested by harvester costs 7,44…7,45 €/m^3 and by chainsaw – 7,43…7,44 €/m^3. The next conclusion of the obtained results shows that some additional studies are needed to determine the differences in tree and stand structures as well as to take different stands in different regions to get some cost information of the transportation of harvester and chainsaw crew between the stands. This study work is already planned to do.

The next results of STSM's work are as follows: (a) my enhanced professional knowledge of the forest resource utilization; (b) the collected database of Polish coppicing; (c) the agreed Polish-Ukrainian collaboration through the joint research project *Efficiency in forest operations.*

• *Planned collaboration with the host institution*

The future collaboration with scientists at Department of Forest Utilisation, Poznań University of Life Sciences, was agreed in three areas:

(1) providing joint research projects on coppicing involving forest enterprises;

(2) publishing scientific papers concerning coppicing, involving also other European co-authors;

(3) academic and scientific staff exchange using Ukrainian, Polish and European funding resources.

Reference

Mederski P.S., Bembenek M., Karaszewski Z., Łacka A., Szczepańska-Álvarez A., Rosińska M. 2016. Estimating and Modelling Harvester Productivity in Pine Stands of Different Ages, Densities and Thinning Intensities. Croat. J. For. Eng. – 37 (1). P.: 27–36.

I confirm completion of the above STSM by Dr. Ivan Sopushynskyy

21.03.2017 Piotr S. Mederski
