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PRODUCTIVITY OF HARWARDER VIMEK BIOCOMBI IN EARLY THINNING IN LATVIA

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ПРОИЗВОДИТЕЛЬНОСТЬ ХАРВАРДЕРА VIMEK BIOCOMBI НА РУБКЕ УХОДА ЗА ЛЕСОМ В ЛАТВИИ

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Во время эксперимента было спилено 17410 деревьев, средний диаметр которых на высоте 1,3 м составлял 3 см, а объем ствола – 0,006 м³. В целом за время рубки ухода было заготовлено и привезено 105 м³ биотоплива. При этом производительность харвардера Vimek на транспортировке лесоматериала в оптимальных условиях не ниже производительности John Deere 810 и аналогичного форвардера среднего класса. Также было установлено, что самая низкая себестоимость (23 € $м^{-3}$) была у биотоплива, полученного после поздно выполненной рубки ухода, а самая высокая (42 € m^{-3}) – при пилении подроста.

Introduction. Average fuel consumption of Vimek 610 Biocombi harwarder intrials was 4.5 L perproductive work hour, which conform manufacturers provided information about fuel consumption while working in harvester mode.

Comparing soil compaction in strip roads, Italian researchers concluded that Vimek 610 BioCombi has significantly less impact to soil. Also soil porosity, which before trials were 40 %, working with Vimek 610 BioCombi decreased to 30 %, but with larger harwarder – to 20 %. 1-4 % of residual trees were damaged; this number was lower for smaller harwarder [1].

According toresults of research Italian scientists concluded that the smallest Vimek 610 BioCombi harwarder is more suitable for pre-commercial thinning (PCT), mainly because it can directly load felled trees in the load bunk [2].

During pre-commercial thinning trials in Latvia (2014) 13 loads of biofuel (unpruned, whole small trees), were prepared and extracted, average load during trials were 2.3 t naturally moist materials. To prepare and extract 1 t of biofuel on average 18 minutes of direct work time was necessary, but for 1 loose m^3 biofuel – 6 minutes. With these productivity indicators during productive work hour one can prepare and extract 9.6 loose m^3 of biofuel. Time study of performing pre-commercial thinnings and extracting biofuel shows that proportion of productive work time is 95 % from total work time [3].

Costs of trials performed in Latvia shows that average work hour costs for Vimek 610 BioCombi harwarder are 22 €; meanwhile, average productive work hour costs are 28 €. Cost of preparing and extracting biofuel was 2.9 € loose m³. By decreasing average annual workload down to 1000 productive work hours, biofuel preparation and extraction costs would increase to 4 € loose m³ [3].

Materials and methods. To perform the trial, 4 stands in compartment No. 711 and 2 stands in compartment No. 712 were selected nearby Talsi city. Criteria for stand selection were average tree height, stand density and terrain suitability for mechanized logging operation.

Thinning (PCT and delayed thinning) were performed without creation of wider openings for technological corridors but by driving between remaining trees (distance between ''ghost roads'' were 6-10 m, width of road 2-2.5 m, which is less than average distance between the re-

maining trees). First, tractor drove into stand while cutting ‘’ghost road’’ and on the way back it thinned rest of the stand. Trees felled during cutting of ‘’Ghost road’’ first were laid on the ground at the side of ‘’ghost road’’ and on the way back they were loaded into the harwarder cargo compartment and forwarder to a roadside with rest of the trees that were removed on the way out. To prepare full load, operators had to plan ‘’ghost roads’’ length ‘’with reserve’’ so there were always some trees left on the ground for next trip.

During thinning time study the machine operations were divided in accounting elements. A shock and waterproof field computer Allegro CX with SDI software was used in time studies. Thinnings were performed by 2 experienced harvester operators, who worked before on John Deere 1070 harvester. Work time consumption was determined for each work cycle separately. Work cycle, in context of this research, is crane work cycle. Productive time elements for understory removal and thinning are: drivingin to stand, reaching tree, grabbing tree, cutting tree, pulling stem from cutting place to piling place, direct loading of ectracted stems into cargo compartment, stem bucking, understory cutting, driving in stand during loading, other work related activities, reaching for logs while loading, grabbing logs while loading, loading of logs into cargo space, arranging load, driving out of stand with load, reaching for logs while unloading, grabbing logs while unloading, unloading logs, arranging log pile, driving during unloading.

To calculate stand volume professor’s I. Liepas developed single tree volume calculation formula was used [4].

For cost and income calculations LSFRI Silava model (Microsoft Excel environment) was used. It was developed to provide functionality of the Forestry Research Institute of Sweden Skogforsk developed FLIS model, using the time study results and other data obtained in earlier studies in Latvia [5].

Results and discussion. Two experienced operators participated in this trials. Each of them worked 2 full 8 hour shifts. Time study included all time when engine was running (to harmonize with machine hours) and small repairs with engine off. Time study didn’t include long repairs and other idleness.

While working with Vimek BioCombi 610.2 harwarder in thinnings, average productive work time consumption to prepare 1 m^3, depending on used method, is characterized by power equation (Figure). While increasing of the average extracted tree DBH, the most rapid growth of productivity is observed in PCT’s, while in understory extraction and delayed thinning increase of productivity is similar and slightly slower.

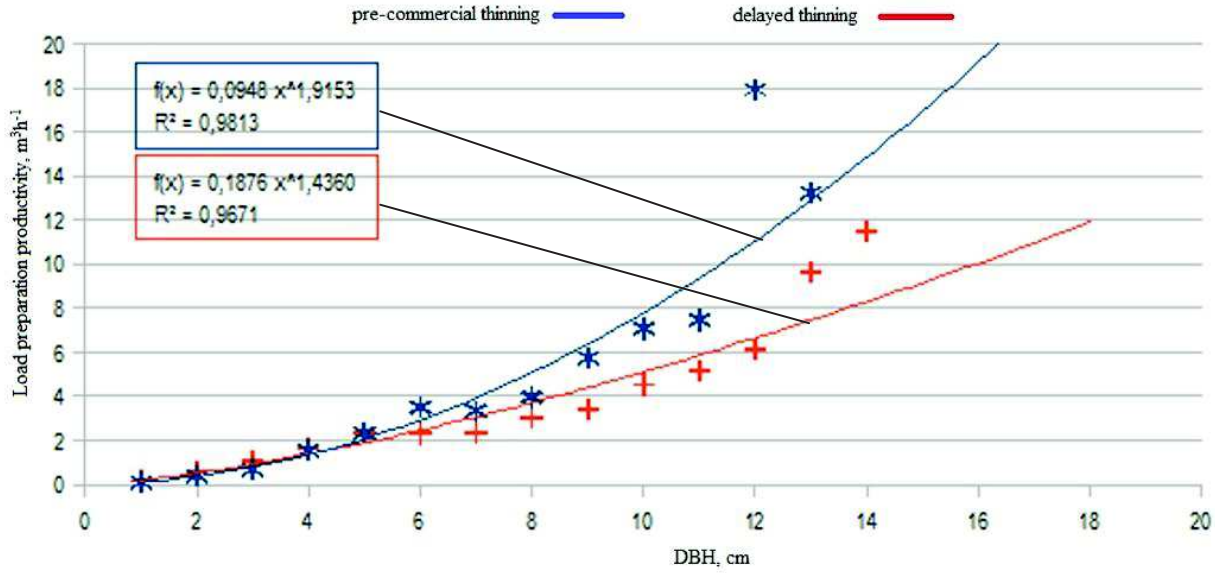

Figure – Productivity indicators for tree felling and processing depending from DBH of extracted tree

In all types of cuttings considerable proportion of work time was spent to cut trees (from 13% in delayed thinning to 19% in PCT). Also, significant share of productive work time was spent to load load trees into a cargo space (form 7% in delayed thinning to 12% in PCT). Driving in and out from stand was also considerable consumer of work time (from 11% in delayed thinning to 36% in understory removal). Driving in stand while loading consumes from 7% of productive time in understory removal to 10 % in PCT. In delayed thinning 9% of productive work time is spent to put extracted logs to the ground while cutting ‘’ghost road’’ and 10% of productive work time is spent to pick up logs that were placed to the ground earlier, respectively, putting of extracted trees to the ground increases loading time approximately 2 times. It was identified in the study that tilt function is very helpful while loading full trees into a harwarder loading space, however separate study is necessary to quantify specific effect of this function.

Average tree DBH in different type of cuttings were determined according to actual DBH of extracted trees during the trials. Indicators, which characterize different type of cutting, are given in table 1.

Table 1 – Cutting type specific input data in cost calculation model

Indicators	Cutting type	
	Pre-commercial thinning	Delayed thinning
Average felled tree DBH, cm	2.6	4.2
Forwarder load, m³	0.9	1.3
Productive time for loading, min per load	33.5	26.3
Productive time for unloading, min per load	2.4	2.3

Pre-commercial thinning biofuel costs amount to 37 € m^{-3}, cutting an average tree of 2.6 cm. Biofuel cost decreased to about 2 times (up to 23 € m^{-3}), when the load average diameter of the tree is at least 4 cm. Positive cash flow reached when the load average diameter of the tree is at least 3.5 cm. Delayed thinning costs amount to 23 € m^{-3}, cutting an average tree of 4.2 cm. Biofuel cost drops to 18 € m^{-3}, when the load average diameter of the tree is at least 6.3 cm. The study was implemented with in the scope of the JSC funded research project 'Research program on forest biofuel and mechanization of forest operations' (agreement No 5-5.9_003v_101_16_47).

Conclusions

1. Productivity of Vimek BioCombi 610.2 harwarder in thinnings and understory removal is equal to average productivity figures in similar conditions other studies that were obtained during this project. Prime cost of biofuel is affected mainly by harvesting method and forwarding distance.

2. Vimek harwarder does not need network of regular technological corridors in thinnings and understory removal to operate efficiently. Average distance between remaining trees in thinning is at least 2,5 m which is enough for harwarder to pass without cutting of trees just to expand road.

3. To reduce cost at pre-commercial thinning the dimensions of the sawing wood should not be less than 4 cm, and at delayed thinning the dimensions of the sawing wood should not be less than 6.3 cm.

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