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LOGGING RESIDUES AS A RENEWABLE ENERGY SOURCE IN POLAND

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ОТХОДЫ ЛЕСОЗАГОТОВОК – КАК ВОЗОБНОВЛЯЕМЫЙ ИСТОЧНИК ЭНЕРГИИ В ПОЛЬШЕ

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Continuous civilization and economic development is inseparably connected with huge amount of energy consumption. In the increasingly energy sector, the fossil fuels are replaced by renewable energy sources. The European Union's energy targets to be met by 2020 say about 20% of EU energy consumption to come from renewable resources. In the case of Poland, the energy share coming from renewable sources by 2020 should increase to 15%. The aim of the study is to present possibilities of logging residues utilization for energy production applied in Polish conditions.

Key words: renewable energy, forest biomass, logging residues bundling, chipping

Introduction

Intense social and economic development observed in many different parts of the world has contributed to a growing interest in various types of energy carriers. According to estimations, during the next thirty years the demand for energy will grow by 30%, and even by ca. 60% in developing countries (Outlook for Energy 2012). Promotion of renewable energy sources (RES) has been especially intense in European Union countries. Under the EC Directive of 2009, presently in force, new objectives were specified with regard to increasing the share of energy from renewable sources in the general balance of energy consumption. The use of RES contributes to the diversification of supply sources and creates conditions for the development of distributed energy based on locally available resources. Taking into account climatic and geographic Polish conditions, it is believed that one of the main energy sources could be biomass, including biomass coming from forests as well.

The recent period has seen a considerable interest in using of logging residues. Previously, for many decades this material found application mainly for the production of small-size wood, used by local communities for the purposes of heating. The remaining parts, such as small twigs and needles of coniferous trees were crushed by specialist machines directly at the cutting site, thus providing a reservoir of nutritional substances for the subsequent tree stand generations (Sadowski and Moskalik 2007). Nowadays, more and more frequently, large heat generating plants as well as heat and power generating plants are willing to receive biomass from logging residues.

The most common supply chain in Poland is based on chipping the raw material at the roadside. Chipping can also take place directly at the logging site, on the terminal, or at a heat generating plant. In Poland for last years bundling of logging residues has been applied with growing success (Moskalik et al. 2016).

Material and method

The paper presents two main processes applied in polish conditions: logging residues chipping and bundling. Research plots where all efficiency measurements of the chipper were conducted were composed of four research plots located in northern part of Poland, out of which three differed mainly with respect to chipping management methods resulting from differences in tree species composition and purposes of silviculture, and one division in which late thinning was applied as an

upkeep treatment. BANDIT 2090 is the model of the chipper whose efficiency has been analyzed. It is a typical compact drum wood chipper. Productive capacity of the chipper, defined as the amount of energy chips produced per unit of time, measured in m^3h^{-1}.

In the case of bundling John Deere slash bundler 1490D was the subject of the study. The basic unit of the bundling device was an eight-wheel forwarder, powered by John Deere 6068 HTJ/136 kW engine.

It was decided that the study would be conducted in three variants. The first variant (V1) focused on the areas where timber harvesting was performed in a traditional way, using a chain saw. Logging residues were evenly distributed over the area and not accumulated. The remaining two technologies were connected with machine acquisition of timber by means of a harvester. In the second variant (V2) the residues were mechanically raked into strips, whereas in the third variant (V3), the trees were cut in such a way that after several trees had been processed it was possible to gather the residues into a pile.

The study area was located in north-eastern Poland and comprised 18 selected plots. All research plots contained coniferous stands, dominated by Scots pine with varying proportions of Norway spruce and scattered birches. Efficiency of the bundler, expressed by the number of bundles h^{-1}, was estimated on the basis of field measurements conducted in selected plots.

Results

Chipping

In analyzed cases, operational productivity ranged from ca. 13.7 to 16.6 m^3h^{-1} (Figure 1). Observed disparities were due to differences in respective tree stands as well as the effect of various types of silvicultural activities performed prior to chipping. The highest productivity was observed under the category of group clear cutting, where three groups were cut, covering the total area of ca. 1 ha. The cutting was performed with chainsaws and low quality timber was arranged into piles, which considerably facilitated work a wood chipper. The lowest productivity was observed in the area of thinning. The outcome was significantly affected by a wide dispersion of the raw material and the fact that the logging residues in that particular area were smaller in comparison to their counterparts in other areas.

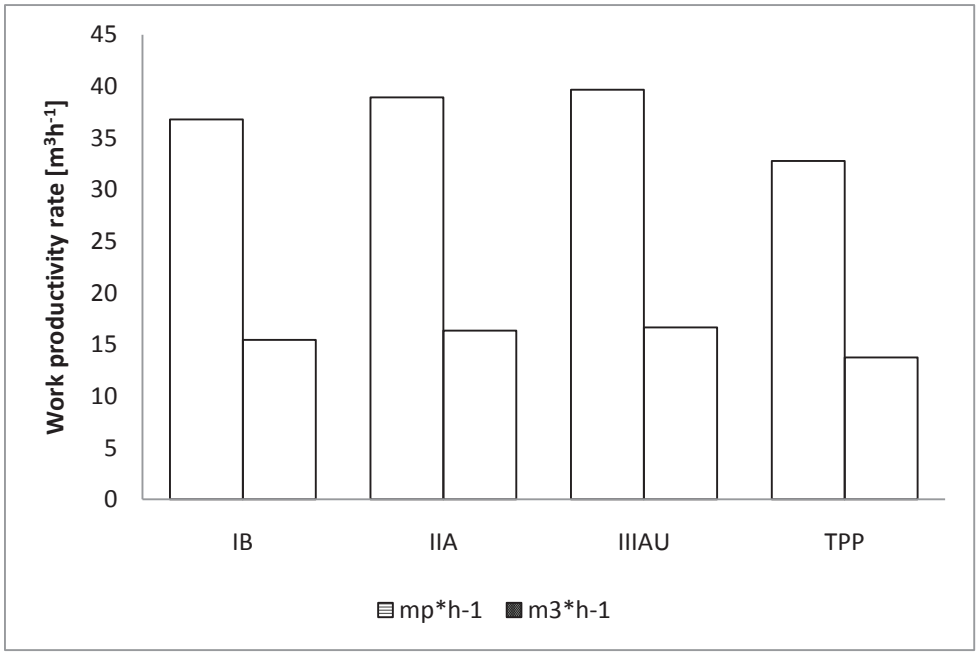

Figure 1 – Operational productivity of logging residues chipping

Bundling

Figure 2 shows average work efficiency values for the analyzed variants. The highest efficiency could be observed in the variant where the residues had been gathered into piles prior to bundling. In that case the average efficiency amounted to 21.85 bundles h^{-1}. In the variant where the residues were scattered, work efficiency equaled 15.21 bundles h^{-1}. Furthermore, it was stated that there were statistically significant differences between efficiency levels achieved in particular variants.

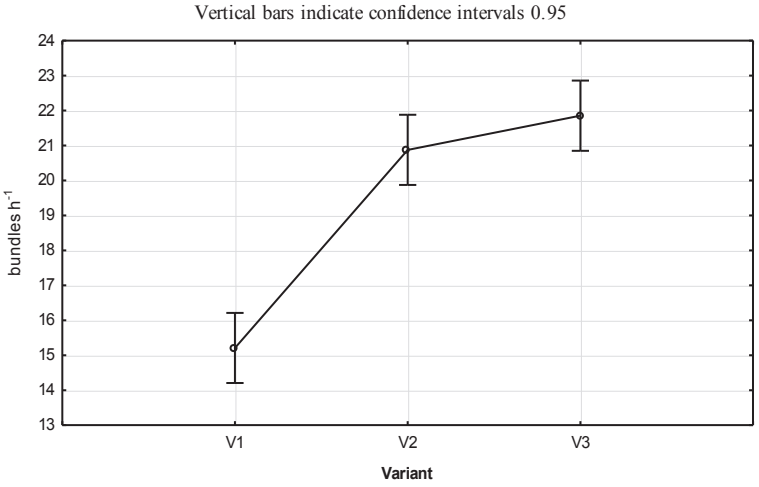

Figure 2 – Average work efficiency of the process of bundling logging residues in particular variants

Discussion

Until the year 2004, in Poland, the most commonly implemented method of using logging residues was burning them directly on the ground after having previously turned thicker branches into fuelwood. Despite the simplicity of this activity, the process of burning had an unfavourable effect on the environment in comparison to other methods. Intense development of technologies for energy acquisition from forest biomass has provided conditions facilitating the use of logging residues on the industrial scale.

Field conditions are one of the most important factors which affect work efficiency in the technological process connected with logging residues utilization. Work efficiency values obtained in the course of the present research were mostly similar to results obtained by other authors. Existing differences were due, first and foremost, to slightly different conditions with regard to performed operations.

Logging residues bundling is beneficial from the point of view of logistics, since it makes possible to use the same technical measures as those used in transporting round wood. In the case of chipping there is a need to use a special containers or trailers.

Conclusions

- Continuously growing worldwide interest in renewable energy sources contributes to the fact that new technologies are sought for, including ones based on forest biomass. One of possible solutions in this field is utilizing logging residues.
- An average operational productivity of the chipping process equaled 15.6 m^3h^{-1}. The values changed depending on tree stand type and ranged from 13.6 to 16.7 m^3h^{-1}. Factors determining the changing values of operational productivity included concentration and arrangement of raw material.

- Effectiveness of the bundling process, expressed by the achieved work efficiency, largely depends on how orderly the residues have been distributed over the forest area. In the case they have been gathered in the form of strips or piles the machine does not have to move all over the work area in order to collect scattered material, which results in an increase in efficiency by 25-30%. This directly affects the amount of unit costs.
- Logging residues bundling can provide an interesting alternative to technologies based on chipping the raw material directly on the chipping sites, especially considering the fact that in the case of bundling it is possible to use standard transport, the same that is used for removal of round wood.

REFERENCES

1. European Commission 2009. Directive of the European Parliament and of the Council on the promotion of the use energy from renewable sources. Brussels.

2. Moskalik T, Sadowski J., Zastocki D. 2016. Wybrane technologiczne i ekonomiczne aspekty balotowania pozostałości pozrębowych. Sylwan 160(1): 31-39.

3. Sadowski. J., Moskalik. T. 2007. Technologiczne i ekologiczne aspekty wykorzystania pozostałości zrębowych na cele energetyczne. Biomasa dla elektroenergetyki i ciepłownictwa – szanse i problemy. Wydawnictwo "Wieś Jutra". Warszawa. s: 193-197.

4. The Outlook for Energy: A View to 2040. http://cdn.exxonmobil.com/~/media/global/files/outlook-for-energy/2016/2016-outlook-for-energy.pdf