

POWER ANALYSIS OF FORESTRY CUTTERS FOR COMMINUTING OF WOOD WASTE IN POPLAR CLEARINGS. PART 1: ENERGY INTENSITY

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ABSTRACT

Forestry milling cutters are increasingly used in modern forest technologies for soil preparation of reforestation. In forestry in Bulgaria, although more limited, there is a tendency for introduction of this kind of machinery. Milling machines have good technological qualities, but they also have some drawbacks, such as high-energy consumption and the need of more power drive. In the present work, an experimental study to determine the energy intensity of PT-400 forest milling unit with FAE-300S multifunctional forestry tiller for comminuting of left slash in poplar clearings, was carried out. Based on the results, regression models were developed to express the energy intensity of the forestry cutter, depending on the operating conditions and speed modes of the milling unit. In conclusion, under certain operating conditions, the optimal technological regimes for the operation of the forest mills are defined.

Key words: soil preparation, poplar clearings, slash, fuel consumption.

INTRODUCTION

Soil preparation for poplar plantations establishment is among the most energy-intensive activities in technology of reforestation. A major factor in reducing the soil preparation cost is the introduction of modern technologies and machines. Depending on applied technologies and operating conditions, the cost of soil preparation may range from 1200 to 2500 €/ha (Keča and Pajić 2015, Marinov and Jordanova 2017a).

Forest cutters for site preparation of forest areas afforestation can be used for various technological operations and they may work as: a forest brush cutters for comminuting of left slash and bushes, as a rotovator for major soil cultivation, as a machine for grinding stumps and roots. In recent years in our country, in the region of Vratsa Northwest State Forestry Enterprise, for soil preparation poplar clearings were introduced two multifunctional forest cutters FAE 300 S, powered by energetic machines Prime Tech, models PT-

300 and PT-400. This led to improving the quality of soil preparation and to reduce labor costs in technology of poplar plantations establishment (Marinov *et al.* 2017).

Along with positive qualities, milling machines are characterized by greater energy intensity and require more power (Hallbrook *et al.* 2006, Marinov and Jordanova 2017b). Under more extreme operating conditions, this can lead to a significant increase in energy costs and to an increase in the total cost of soil preparation. From the reference made in the Vratsa NWSF, it was established that, depending on the operating conditions, the price of the soil preparation of the poplar clearings with the milling unit PT-400 is within the range of 1350÷1800 €/ha (Marinov *et al.* 2017). A major share in the formation of this price takes fuel consumption, which is the 55÷65% of the final price for soil preparation. This shows the great importance that energy costs have in the exploitation of forestry cutters.

The aim of this study is to research the impact of major kinematics and technology factors on the energy intensity of forest cutters for comminuting of left slash, shoots and shrubs in poplar clearings.

To achieve the goal of the research, the following tasks are solved: 1/ Experimental determination of the energy costs of the PT-400 forest milling unit with FAE 300S multi-purpose milling machine for chipping of wood waste, shoots and shrubs in poplar clearings; 2/ Development of appropriate mathematical models under certain production conditions for expressing the correlation between the technological and kinematic indicators of the milling cutter and its energy intensity; 3 / Optimization of the technological process and identification of the most efficient modes of operation of the milling machine.

MATERIALS AND METHODS

OBJECT, SUBJECT AND PLACE OF STUDY

Object of the study is a self-propelled forest milling unit consisting of an energetic

machine PrimeTech PT-400 and the working machine – multi-purpose forestry cutter FAE 300S-225 (Fig. 1). The power unit is equipped with a diesel engine CAT C-13, with a rated output of 310 kW (415 HP). The machine has a crawler drive system with a chain with a width of 800 mm. This ensures high passability and a high traction force of 275 kN, a low level of soil compaction – 0.35 kg/cm², and the possibility to working on over-wetted terrains. Two hydrostatic systems with controllable piston-axial pumps and hydro motors are used to drive the transmission and working bodies. In this way, the frequency of rotation of the milling drum can be adjusted from 0 to 500 min⁻¹. The working bodies of the milling cutter consists of 92 chisel blades, staggered around the periphery of the milling drum, with a diameter of 0.70 m and a working width of 2.30 m.



**Figure 1: PT 400 specialized milling unit with FAE300S multi-purpose forestry tiller
(Photo K. Marinov)**

The subject of the study is the operating productivity, fuel consumption and energy

intensity of the milling machine for shredding of wood waste, shoots and shrubs in



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