WORK PRODUCTIVITY ANALYSIS IN THINNING INTERVENTION OF CHESTNUT COPPICE IN CENTRAL ITALY

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ABSTRACT: Thinning interventions are crucial for the correct growth of chestnut coppices. Such intervention generally does not allow for the extraction of high value timber, but it generally produces only low diameter poles and fuelwood. According to this, improving work productivity is fundamental to ensure economic effectiveness of this sylvicultural treatment. This study was set up in Lazio Region in Italy. Work productivity in thinning intervention of a chestnut coppice was analyzed, evaluating the working performance of an unusual harvesting system, the use of which was possible thanks to the low values of slope and roughness in the forest area. Felling and processing operation was motor manual with chainsaw, while bunching-extraction was carried out in part by an excavator equipped with grapple, and the extraction-transport was performed by wheeled truck. Gross productivity of felling and processing operations resulted to be 2.125 t h^{-1}, bunching-extraction productivity was 2.381 t h^{-1} and, for the extraction-transport, a productivity of 4.791 t h^{-1} was assessed. Findings show a good work productivity, mainly due to the excellent topographic conditions that allowed the wide use of mechanical means for forest operations. The improvements that can be made consist essentially in the use of mechanization level that allows a lower impact on soil and the implementation of forest operators skill.
Keywords: work performance, cost analysis, slope, roughness, fuelwood

1 INTRODUCTION

Implementing sustainable forest operations is a key issue to ensure correct and sustainable forest management [1]. The concept of sustainability implies to perform harvesting operations in agreement with the requirements of all the three pillars of sustainability [2–6]. Chestnut (*Castanea sativa* Mill.) coppice is one of the most represented production forest typologies in Italy [7,8]. This kind of forest is able to produce high value timber from final cut, but, for the correct development of the trees, thinning interventions are fundamental [9,10]. These interventions are generally not able to produce high value timber, but the assortments can be used for both small-caliper roundwood and firewood [11,12]. The present case-study shows the work performance analysis of a thinning intervention in chestnut coppice, performed with an unusual harvesting system, enabled by the favorable topographic conditions of the forest area. The harvesting system consisted of: motor-manual felling-processing by chainsaw, bunching-extraction by excavator equipped with a grapple, and extraction-transport by wheeled truck.

2 MATERIALS AND METHODS

2.1 Study area

Intervention surface of 12 ha was located in Velletri (Lazio, Italy). The sub-compartment showed negligible value of slope and roughness. Average dbh was 9 cm and average height 11.9 m.

2.2 Description of the harvesting system

The applied harvesting system was Cut to length (CTL). Motor manual felling and processing was performed by Stihl 018, Stihl 066 and Stihl 036 chainsaws. Bunching-extraction operation was carried out through a Takeuchi 5.5 t excavator equipped with GMR 1300 Agriforest grapple (Figure 1). Extraction-transport of the piled material was performed by a Nissan Ebro wheeled truck (Figure 2).

Figure 1: Delimbing operation.

Figure 2: Loading phase of extraction operatio

2.3 Work productivity evaluation

Work productivity analysis was performed according to the methodology reported in Picchio et al. [13] by measuring working time through a time-table (Figure 3). In detail, gross productivity (PHS_{15}) and net productivity (PHS_0) were assessed. Measure unit for work productivity is $t_{fm}h^{-1}$, thus referring to the harvested fresh biomass in one hour.

Figure 3: Measuring of working times.

3 RESULTS AND DISCUSSIONS

Results of the work productivity analysis is given in Table I.

Table I: Work productivity of the various operations.

Operation	PHS_0 (t_{fm} h^{-1})	PHS_{15} (t_{fm} h^{-1})
Felling-processing	2.125	1.700
Bunching-extraction	2.381	2.223
Extraction-transport	5.437	4.791
Yard productivity	0.945	0.906

As shown in the previous table work productivity was rather high. This is mainly due to the optimal topographic conditions of the sub-compartmentIndeed, both slope and roughness were very low, thus simplifying mechanical bunching and extraction. On the other hand, in the forest yard there was a high level of disorganization, mainly due to the low level of experience of workers and, mostly, to the absence of a proper planning of the intervention. This, along with the use of not forest specific machineries, caused an extended impact to soil, with negative implications regarding the issue of sustainable forest management [14,15]. In particular, the excavator and the truck practically drove all along the entire forest surface, without any preliminary planning, with detrimental implication on forest soil [16].

4 CONCLUSIONS

The investigated harvesting systems showed high work productivity but, on the other hand, the absence of a proper planning of the intervention cause extended impact to soil.

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