

FELLING OPERATION IN ARTIFICIAL CONIFEROUS STANDS: WORK PRODUCTIVITY ANALYSIS

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ABSTRACT: The increasing need in renewable energy production is fostering the utilization of Italian artificial coniferous stands for wood chips production. On the one hand, such interventions are crucial for the development of the forest stand, however, the low economic value of wood chips not often guarantees a positive stumpage value. According to this issue, studies dedicated to analyze and improve working productivity in pine stands interventions are fundamental for the correct development of the value chain. The present work analyzed three different forest yards in Central Italy, in order to evaluate the differences in work productivity between motor manual and fully mechanized felling. In particular, two motor manual and one fully mechanized felling operations were analyzed. The work productivity in fully mechanized felling by Harvester TimberJack 1270 showed a very high value of 28.18 t h⁻¹, which resulted substantially higher than motor manual felling productivity (1.84 and 4.18 t h⁻¹). Obviously, the use of fully mechanized felling is linked to the improvement of forest operator skills, furthermore it can be positive not only concerning economic aspects but also for social purposes, through limiting the possibility of work accidents and increasing the comfort of forest operators.

Keywords: thinning, forest management, sustainable forest operations, harvester, Cut to length CTL

1 INTRODUCTION

Pine forests are widely represented and distributed across the world, and in Italy this kind of stand is mostly of artificial origin [1]. Extensive plantation activity, mainly for hydrological purposes, was performed during the previous century [2]. One of the most important forestry interventions to be carried out in this kind of artificial plantation is thinning [3]. Thinning is in fact significant for the correct development of the stand and to avoid predisposing factors of wildfires [4–6]. Unfortunately, due to economic issues, these interventions have not been extensively carried out in Italian pine plantations [7]. One possible solution is the appliance of mechanized harvesting systems, in order to increase the working productivity [8]. Enhancing working performance is indeed crucial to achieve the economic sustainability of forest operations, allowing for positive stumpage value even by interventions in which only fuelwood can be obtained [9]. In this study, a comparison of working times and productivity, between motor-manual and mechanized felling, was carried out in artificial pine plantations in Italy.

2 MATERIALS AND METHODS

2.1 Study area

Three different forest yards, located in different areas, were studied. Details of the study areas are given in Table I.

2.2 Work productivity evaluation

Working performance analysis was carried out with the methodology proposed by [10,11]. In particular, gross productivity (PHS₁₅) and net productivity (PHS₀) were calculated by measuring working time through a chronometer. Measure unit for work productivity is t_{dmh}⁻¹, thus referring to the tons of dry biomass felled by one worker in one hour.

Table I: Features of the studied areas.

	Monte Peglia (MP)	Casalotti (CS)	Monte Brugiana (MB)
Main species	<i>Pinus nigra</i>	<i>Pinus halepensis</i> and <i>Pinus pinaster</i>	<i>Pinus pinaster</i>
Intervention surface (ha)	13.91	2.00	8.00
Stand age (year)	33	35	52
Intervention	Geometric-selective thinning	Geometric-selective thinning	Selective thinning
Average slope (%)	45	15	45
Roughness (%)	30	0	20
Working system	WTS (Whole Tree System)	WTS (Whole Tree System)	WTS (Whole Tree System)
Felling	Chainsaw	Harvester	Chainsaw
Stand density (n° ha ⁻¹)	1326	982	684
Avg. dbh (cm)	20.3	22.9	22.0
Avg. height (m)	16.2	18.0	15.9

Stand volume (m ³ ha ⁻¹)	468.479	466.450	202.464
Harvested volume (m ³ ha ⁻¹)	303.504	246.432	99.524

3 RESULTS AND DISCUSSIONS

Results of work productivity evaluation of the investigated felling systems are reported in Table II.

Table II: Work productivity analysis results.

	MP	CS	MB
PHS ₀ (t _{dm} h ⁻¹)	3.45	34.54	4.87
PHS ₁₅ (t _{dm} h ⁻¹)	1.94	28.18	4.18

As it is possible to notice, mechanized felling through harvester showed substantially higher work productivity than motor-manual felling. Moreover, the improvement possibility of the work performance in mechanized felling is comparable with MB and also substantially higher than MP.

4 CONCLUSIONS

Applying harvesting systems based on dedicated forest machineries, and with high level of mechanization, could be the solution to deal with the poor stumpage value related to thinning treatments in coniferous stands, and particularly in plantations.

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6 ACKNOWLEDGEMENTS

The work was performed in the framework of the project Suscace (“Supporto Scientifico alla Conversione Agricola verso le Colture Energetiche”).

