

## HEAVY GRAVITY CABLE YARDING IN ITALIAN ALPS, OPERATION PLANNING AND LOGISTIC

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**ABSTRACT:** European Union is strongly encouraging renewable energy production from biomass, and forests show a major role in this context. Italian Alps zone is one of the few that, in Italy, presents wide application of aerial extraction systems, like cable yarder. Proper analysis of work productivity and costs of such kind of harvesting system could be the starting point for their introduction even in central and south Italy. According to what previously stated, the main aim of the present study was the analysis of an harvesting system, consisting of motor manual felling with chainsaw, bunching and extraction by heavy gravity cable yarder and final processing by an excavator-based with processing head. This harvesting system allowed for the production of both timber and wood chips, these last from little branches and tops. Gross productivity of the overall harvesting systems resulted to be 6.217 m<sup>3</sup> h<sup>-1</sup> with net productivity of 6.486 m<sup>3</sup> h<sup>-1</sup>. Harvesting cost was 35.18 € m<sup>-3</sup>. This system showed therefore high productivity and limited costs, even if there is a certain degree of possible improvement.

**Keywords:** Norway spruce, larix, extraction, work productivity, cost analysis, cable yarder

### 1 INTRODUCTION

Aerial extraction systems, in particular cable yarder, are widely used in mountainous forest operations, in particular with steep slope conditions [1,2]. These systems, if well applied, show high productivity and reduced impacts to soil [3–6]. Therefore, cable yarders can provide suitable solutions to reach the aim of sustainable forest operations [7–10]. However, cable yarders are not very present in Italy, except for Northern Italy where they represent one of the most applied harvesting systems. The major reason of the scarce application of cable yarders in central and southern Italy relies in the need of improving the skills of both operators and forest engineers, since aerial extraction implies different approaches and techniques compared to ground-based extraction. Moreover, there is also a kind of rejection from forest enterprises regarding cable yarders, which are considered productive but very expensive. This is only partially true, and the first step to remove this blockade is evaluating productivity and costs of these systems in a scientific way. Several studies dealt with productivity assessment of cable yarders, and the present work represents a case-study concerning the evaluation of harvesting systems able to produce both timber and wood chips.

### 2 MATERIALS AND METHODS

#### 2.1 Study area

Study area consists in a high forest of *Picea abies* (L.) H.Karst. and *Larix decidua* Mill. located in Ronchi Valsugana (Trentino Alto Adige, Italy). The surface of the sub-compartment was 5 ha and the applied intervention consisted of a thinning, removing mainly Norway spruce trees.

#### 2.2 Description of the harvesting system

Full Tree System (FLS) was applied with motor-manual felling by STIHL MS 661 C-M chainsaw. Bunching and extraction was performed through a heavy

gravity cable yarder VALENTINI V850 M3 (Figure 1). At the landing site, an excavator-based processing header KONRAD WOODY 60 (Figure 2) performed the final processing of wooden material between high value timber and residual to be chipped for bioenergy production.



**Figure 1:** Cable yarder VALENTINI V850 M3.



**Figure 2:** Processing header KONRAD WOODY 60.

Three different cable yarding lines were installed for extraction operation (Table 1).

**Table I:** Data regarding cable yarding lines.

	Line 0	Line 1	Line 2
Length (m)	278.72	249.13	269.28
Lower altitude (m a.s.l.)	1342.33	1341.22	1349.94
Higher altitude (m a.s.l.)	1438.58	1428.46	1461.55
Avg. slope (%)	37.2	38.8	46.6
Max slope (%)	55.8	87.24	67.3

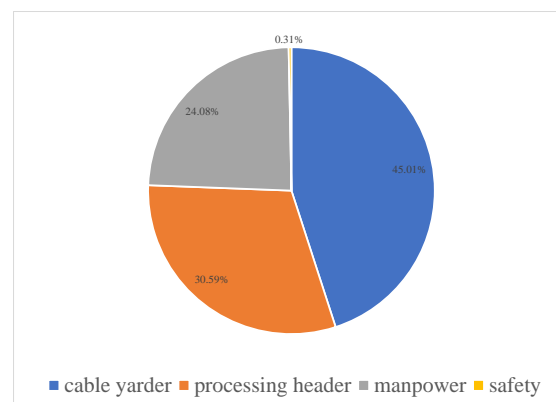
### 2.3 Work productivity evaluation

Work productivity analysis was performed according to the methodology reported in Picchio et al. [11]. In detail, gross productivity (PHS<sub>15</sub>) and net productivity (PHS<sub>0</sub>) were evaluated by surveying working time through a chronometer. Measure unit for work productivity is m<sup>3</sup>h<sup>-1</sup>, thus referring to the harvested volume by the complete working team (3 workers) in one hour. Subsequently, cost analysis was carried out according to Picchio et al. [12].

## 3 RESULTS AND DISCUSSIONS

The productivity of the overall harvesting system was 6.217 m<sup>3</sup>h<sup>-1</sup> PHS<sub>15</sub> and 6.486 PHS<sub>0</sub>. With a possible improvement of 4.2%. Furthermore, the high level of skills of the operators, which were experienced in aerial extraction, allowed for a very efficient harvesting system.

Harvesting costs resulted in 35.18 m<sup>3</sup> h<sup>-1</sup>, in line with what reported by previous studies on the topic [4–6]. The share of the various costs of the harvesting system is given in Figure 3.



**Figure 3:** Harvesting costs percentage sharing.

## 4 CONCLUSIONS

Cable yarders are suitable extraction systems for mixed timber-biofuel production in steep terrains. The key issue when applying these systems relies in the need of skilled manpower. To extend the appliance of these systems also in other parts of Italy there is a need of collaboration between academic and technical forest sectors, in order to allow forest operators to become more familiar with aerial extraction machineries.

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