FOREST OPERATION IN HIGH SLOPE: PRELIMINARY CONSIDERATIONS ON THE POSSIBILITY OF SUBSTITUTING CABLE YARDER WITH HELICOPTER FOR TIMBER EXTRACTION

Latterini F.[1*], Stefanoni W[1]., Pari R[2]., Lazar S.[1], Venanzi R[3]., Tocci D[3]., Picchio R[3].
[1]Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Unità di ricerca per l'ingegneria agraria - Monterotondo (Rome-Italy) francesco.latterini@crea.gov.it; walter.stefanoni@crea.gov.it; sandu.lazar@crea.gov.it
[2]Roma Tre University, Faculty of Law, Via Ostiense, 163, 00154 Roma RM, rob.pari@stud.uniroma3.it
[3]Tuscia University, DAFNE Department, venanzi@unitus.it; toccidamiano91@gmail.com; r.picchio@unitus.it
[*]Correspondance: francesco.latterini@crea.gov.it

ABSTRACT: In Italy a large part of mountainous territory is characterized by high slope. Forest operations in such steep areas requires the usage of aerial extraction systems. Cable yarder is the most applied extraction system, but it is not the unique in this category. Another possible solution is the application of helicopters for logging activities (i.e. heli-logging). This study is a preliminary one, in which literature data are used to compare work productivity of cable yarders and helicopters in extraction operation performed in Italian Alps. Several cable yarders and different helicopter models were compared concerning working performance and extraction costs. Even if without a direct experimental evaluation of the harvesting systems, this study is a very first step of analysis to evaluate the possibility of heli-logging introduction in the Italian context. Productivity of heli-logging resulted to be in the range between 7.5 m^3 h^{-1} and 25 m^3 h^{-1}, with harvesting costs ranging from 52.77 to 62.30 € m^{-3}. According to our findings, extraction with helicopter is much more expensive than cable yarding, and it can be effective only in particular situations.
Keywords: work performance, cost analysis, heli-logging, steep slope

1 INTRODUCTION

In the case of steep slope terrain, aerial extraction systems is the most suitable option for forest operation [1]. The usually applied aerial extraction system is cable yarder [2,3]. However, helicopter extraction (i.e. heli-logging) could be a suitable solution in particular cases, for instance in salvage logging operation [4,5]. In Italy heli-logging is practically absent. The first step for its implementation is a productivity and cost assessment [6,7]. In the present work, a literature analysis of productivity and costs of heli-logging is presented in order to give a preliminary idea of the suitability of these systems, making a comparison with cable yarding costs and productivity.

Figure 1: Heli-logging.

2 MATERIALS AND METHODS

Systematic literature review was carried out within Scopus database in order to give to the reader an overview of literature findings regarding both heli-logging and cable yarder extraction productivity and costs.

3 RESULTS AND DISCUSSIONS

Literature data on cable yarder and heli-logging performance and costs are given in Table I.

Table I: Heli-logging and cable yarding productivity and costs from literature analysis.

Reference	Machinery	Productivity (m^3 h^{-1})	Costs (€ m^{-3})
Manzone and Balsari [8]	Eurocopter AS 350 "Ecureuil" helicopter	19	62.30
Manzone and Balsari [8]	104 kW cable yarder	7.5	14.30
Faccoli et al. [9]	Not specified helicopter	13.3	58
Messingerová and Tajbos [10]	Mil Mi-8 heli- copter	25	Not available
Wang et al. [11]	Boeing Vertoi 107 helicopter	23.04	52.77
Picchio et al. [12]	Savall cable yarder	6.1	15.1
Picchio et al. [12]	Maxwald cable yarder	5.7	14.8
Baek et al. [13]	K301-4 cable yarder	11.35	11.51
Schweier and Ludowicy [14]	Koller Forsttechnik GmbH K507 cable yarder	20.3	12.7

Table I results show how heli-logging is able to reach very high work productivity, but with high costs. Thus this system can be suitable only in some limited cases, for example in presence of very high value timber or when the productivity of the interventions is more important than its cost-effectiveness [9]. This situation is possible in the case of salvage logging or phytosanitary intervention, when the aim of the intervention is more removing an environmental threat than cost-effectiveness [15].

4 CONCLUSIONS

The high costs of timber extraction through helicopters limit their application only to particular cases, where their very high work productivity allows to solve emergency issues in the forest stand.

5 REFERENCES

[1] R. Picchio, P.S. Mederski, F. Tavankar, How and How Much, Do Harvesting Activities Affect Forest Soil, Regeneration and Stands?, Curr. For. Reports. 6 (2020) 115–128. https://doi.org/10.1007/s40725-020-00113-8.

[2] J. Schweier, B. Blagojević, R. Venanzi, F. Latterini, R. Picchio, Sustainability Assessment of Alternative Strip Clear Cutting Operations for Wood Chip Production in Renaturalization Management of Pine Stands, Energies. 12 (2019) 3306. https://doi.org/10.3390/en12173306.

[3] G. Erber, R. Spinelli, Timber extraction by cable yarding on flat and wet terrain: A survey of cable yarder manufacturer's experience, Silva Fenn. 54 (2020) 1–19. https://doi.org/10.14214/sf.10211.

[4] M. Bernard, K. Kondak, G. Hommel, A slung load transportation system based on small size helicopters, in: Auton. Syst. Manag. Control, Springer, 2008: pp. 49–61.

[5] A.E. Akay, J. Sessions, P. Bettinger, R. Toupin, A. Eklund, Evaluating the salvage value of fire-killed timber by helicopter—effects of yarding distance and time since fire, West. J. Appl. For. 21 (2006) 102–107.

[6] L.E. Christian, A.M. Brackley, Helicopter logging productivity on harvesting operations in southeast Alaska, using ecologically based silvicultural prescriptions, West. J. Appl. For. 22 (2007) 142–147.

[7] S. Grigolato, S. Panizza, M. Pellegrini, P. Ackerman, R. Cavalli, Light-lift helicopter logging operations in the Italian Alps: a preliminary study based on GNSS and a video camera system, Forest Sci. Technol. 12 (2016) 88–97. https://doi.org/10.1080/21580103.2015.1075436.

[8] M. Manzone, P. Balsari, Comparison between helicopter and cable crane in logging peration, Chem. Eng. Trans. 58 (2017) 319–324. https://doi.org/10.3303/CET1758054.

[9] M. Faccoli, V. Finozzi, P. Gatto, Sanitation felling and helicopter harvesting of bark beetle-infested trees in alpine forests: An assessment of the economic costs, For. Prod. J. 61 (2011) 675–680. https://doi.org/10.13073/0015-7473-61.8.675.

[10] V. Messingerová, J. Tajboš, Technological and environmental parameters of helicopter timber extraction in Slovakia, Croat. J. For. Eng. 27 (2006) 123–133.

[11] J. Wang, S.T. Grushecky, J. McNeel, Production analysis of helicopter logging in West Virginia: A preliminary case study, For. Prod. J. 55 (2005) 71–76.

[12] R. Picchio, R. Venanzi, N. Di Marzio, D. Tocci, F. Tavankar, A Comparative Analysis of Two Cable Yarder Technologies Performing Thinning Operations on a 33 Year Old Pine Plantation: A Potential Source of Wood for Energy, Energies. 13 (2020) 5376. https://doi.org/10.3390/en13205376.

[13] S.-A. Baek, K.-H. Cho, E. Lee, Performance Comparison for Two Cable Extraction Machines in a Larix kaempferi (Lamb.) Carr. Plantation, Sustainability. 12 (2020) 8864. https://doi.org/10.3390/su12218864.

[14] J. Schweier, C. Ludowicy, Comparison of A Cable-Based and a Ground-Based System in Flat and Soil-Sensitive Area: A Case Study from Southern Baden in Germany, Forests. 11 (2020) 611. https://doi.org/10.3390/f11060611.

[15] R. Picchio, R. Venanzi, F. Tavankar, I. Luchenti, A. Iranparast Bodaghi, F. Latterini, M. Nikooy, N. Di Marzio, R. Naghdi, Changes in soil parameters of forests after windstorms and timber extraction, Eur. J. For. Res. 138 (2019) 875–888. https://doi.org/10.1007/s10342-019-01210-5.

6 ACKNOWLEDGEMENTS

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