An analysis of cable yarding in Toscana Region: effective production and work conditions

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Summary

1. Introduction

The timber harvesting is still one of the most important forestry activities in Southern of Europe but the forests are mainly located in steeply sloping mountainous areas where ground-based wood extraction is still the most common harvesting technique employed. The extraction of forest products is a very difficult, expensive and time-consuming operation (Lindroos & Cavalli 2016). This problem is very important because the forests of Mediterranean are located in mountainous areas (Zimbalatti & Proto, 2009). Mediterranean forests are characterised by a remarkable set of features that make them naturally and aesthetically attractive, on the one hand, but also quite fragile, on the other, therefore calling for careful strategies for their conservation and management (Scarascia et al 200). An exceptionally large variation of environmental conditions characterises the Mediterranean countries, where the environment can limit forest growth and succession but can also give rise, more often than it is supposed, to lush, mesic forest ecosystems, similar to those of central Europe (Scarascia et al 2000). Moreover, Mediterranean forests contain an ample, plant and animal biological diversity, exemplified by the large number of tree species as compared to Nordic forests, and by their relatively high genetic variability due to the survival of many conifer and broadleaf species in southern European refuges, during the glacial periods. Another peculiar aspect of this region is the long-lasting manipulation of trees, forests and landscapes, since ancient times, with the diffusion all over the Mediterranean basin of such species as *Pinus Halepensis, Pinus pinea, Cupressus sempervirens, Castanea sativa*, and *Quercus sp*. The harsh and unpredictable climate, the difficult socio-economic conditions and the history of over-exploitation of the Mediterranean forests require that a specific forest harvesting conditions and sustainable forest management should be implemented. In particular, the need for identifying those forestry techniques that allow operations in accordance with the ecological and social conditions.

The coppice harvesting is a specific forestry work, in the case of Spain the current forestry works are related with a forestry tractor (skidder) for hauling with some workers (chainsaw) for cutting and helping the hauling, sometimes equipped with specific forest machines like winches, hydraulic cranes, log grapples but also, the use of animals for gathering and yarding is still widely used. The low level of mechanisation in Spanish forests can be attributed to their site features, the characteristics of the property, the small areas of many of the enterprises, the scant knowledge of modern machinery, and the scarcity of relevant studies relating to the use of modern machinery. The wood from coppice areas in Spain is mainly destined for the production of firewood, thus, the use of cable cranes in Spain remains limited.

In Italy the use of cable logging is more common than in Spain, seems that is normal. In fact, there are some specific companies that are working to do forest machines for cable logging

2. Purpose

To take knowledge in the use of cable logging in chestnut forest in Apennines (Tuscany), under conditions apparently similar than Catalonia (Spain). Taking cycle times in currents work of the cable logging.

3. Locations

The area the study was two sites in Tuscany (Italy): Montepiano in Prato province (DD: 44.096598; 11.155461) and Via del Pian di Giuliano in Pistoia province (DD: 44.0299451; 10.882267). In the last one were studied two lines of cable logging (two different kind of forests).

Work site	A	B	C
Figures	1	2	3
Place name	Pian di Giuliano I	Pian di Giuliano II	Montepiano
Province	Pistoia	Pistoia	Prato
Elevation (m)	810	800	990
Species	Chestnut, Oak	Fir tree, Chestnut	Chestnut, Beech
stand type	coppice	coppice and high forest	coppice
Operation	clear cutting	clear cutting	clear cutting
Density (trees/ha)	2.317	520	1.619
nº stump/ha	572	95	413
Volume site (m3/ha)	538	378	618
Average tree m3	0,23	0,66	0,38
Average slope (%)	60	50	50
Extraction	uphill	uphill	uphill

A. Via del Pian di Giuliano (Chestnut forest)

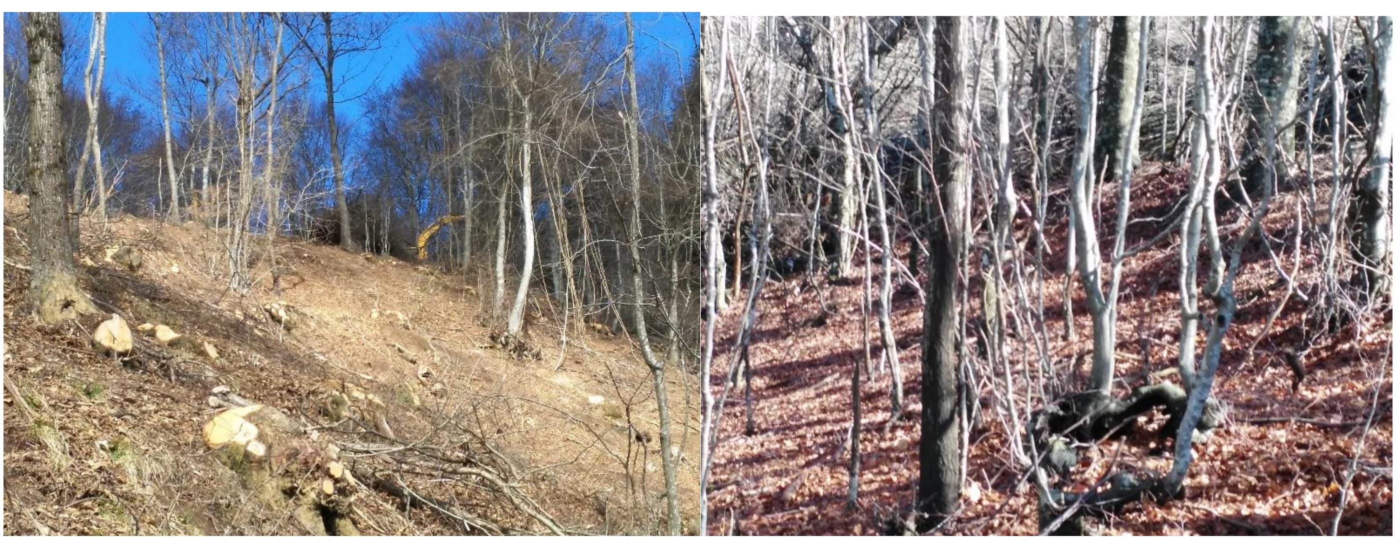

Figure 1 Kind of forest in the first line of cable logging in Pian di Giuliano (Navarro, P. 2017)

B. Via del Pian di Giuliano (Douglas and Chestnut forest)

Figure 2 Forest in second line cable logging in Pistoia Province (Chestnut, Fagus sylvatica, Douglas..) Left after the cutting trees and right before the cutting (Navarro P. 2017)

C. Montepiano (Chestnut forest)

Figure 3 Forest in Montepiano, cable logging with Greifenberg equipment (Navarro, P. 2017)

4. Machines

Carriages:

The carriages are designed for intense working cycles. These carriages are equipped with anti-sliding braking blocks on the carrying and pulling cable and are remotely-controlled: this enable the transfer also when the load is not fully recovered. The hydraulic system is equipped with an integrated recharging system that accumulates power during the translations along the line, and it is equipped with safety valves. The carrying cable stability is guaranteed by four automatically opening and closing blocks that prevent it from derailing when moving on the guide rail. The CRG series (figure 4) are equipped with safety devices including an automated system that promptly blocks the carriage on the carrying cable if the pulling cable breaks, thus keeping the load safe. Is presented a table with the main characteristics of the carriages studied in the STSM.

Technical data		CRG 15 (figure 4)	CRG 25 (figure 4)
Max Load (tons)		1,5	2,5
Operating voltage (v)		12	
Carrying Cable diameter		19	22
Pulling cable diameter (mm)		8-13	
Overall speed (m/s)		14	
Weight (kg)		145	245
Control		remote	
minimum slope (°)		15	
Working time (years)		>15	>5
kind of hitch		chains	steel cable
Dimensions	Length (m)	0,95	1,3
	Height (m)	1,3	1,4
Duration of battery (days)		<1	2-3
Comments		Problems with the battery/electrical connexions	

Table 1: The carriages during the STSM study

Figure 4 The carriages. Left Greifenberg CRG 25 (Picchi, G. 2017); Right Greifenberg CRG 15 (Navarro P. 2017)

Towers:

Towers studied (figure 5)			
	Concepts	Greifenberg tg 700	Valentini V400
Skyline	Installed on	Independent	Tractor
	cable capacity (m)	700	400 (450)
	Cable Ø (mm)	20	17 (16)
Mainline	Cable capacity (m)	700	400
	Cable Ø (mm)	10	10
	Pulling power (kN)	21-31	21-31
	Pulling speed (m/sec)	9,7	3-4,5
Diesel engine power (hp)		109	Tractor min. 120
Tower height (m)		09-12	10
Dimensions in transport mode	Width (m)	2	0,8
	Length (m)	6,3	5,5 (tractor included)*
	Height (m)	2,75	2,5*
	Weight including cables (t)	6	3,8

Figure 5Left Greifenberg TG 700 in Montepieano site; Right Valentini V400 in Pistoia site (Navarro, P. 2017)

5. Methodology

For each site the procedure was:

a) Site data collection: a basic forest inventory in the felling area, collecting diameters of stumps and standing trees.
b) Data from machines, asking the forests workers and seeing the technical information on the machine.
c) Data collection of forest cycles, specific of cable logging. The time data collected is the effective work in the whole process using cable logging. Taking different times: unload trip (from the tower to the skidding area), cable down (cable for skidding from the carriage to worker), gathering of logs (including the time of safe are for the worker), skidding (from the terrain to carriage), loaded trip (from skidding area to tower) and finally unloading (disengage of logs/trees).
d) Other information collected: 1) distance from the tower to skidding area, 2) distance from carriage to gathering logs, 3) size of the load (diameter and length) and 4) number of trees for each load.

NOTE:

1- as for few days were rain, those days was taken to consult and entry data.
2- A day was change of line (from line 1 in Via Pian di Giuliano to Line 2), the time of disassembly and assembly was caught.
3- Using the size of load is possible to calculate the volume of the load, using the reference "Estimation of biomass chestnut" (Tabacchi et al, 2011).
4- In annex 1, it shows the model of timesheet.

Figure 6 Left taking data time by cycle (Picchi, G. 2017); Right taking size data from load (Navarro, P.2017).

6. Results

From cycle works (effective work of cable logging):

Tower		TG 700		V400		V400	
Carriage		Greifenberg CRG 25		Greifenberg CRG 15		Greifenberg CRG 15	
Place		C		A		B	
Workers		4 (tower, skidding, processing, classifying)		3 (tractor/tower, skidding, processing/classifying)		4 (tractor/tower, skidding, processing, classifying)	
n (number of cycles)		20		38		86	
Concept	Units	Average	SD	Average	SD	Average	SD
Unloaded trip	minutes	**00:38**	00:09	**00:37**	00:11	**00:24**	00:08
Down cable (figure 7)	minutes	**00:07**	00:03	**00:35**	00:10	**00:17**	00:06
Load	minutes	**04:27**	00:45	**04:49**	02:02	**02:42**	01:26
Skidding	minutes	**00:53**	00:38	**00:57**	00:14	**00:37**	00:43
Loaded trip (figure 7)	minutes	**01:00**	00:18	**00:54**	00:24	**00:30**	00:18
Unload	minutes	**01:15**	00:26	**00:45**	00:20	**00:37**	00:20
Total time	minutes	***08:20***	*01:08*	***08:37***	*02:21*	***05:07***	*01:41*
Weight	tons	**0,89**	0,48	**0,63**	0,29	**0,74**	0,68
Skyline (from tower to carriage)	meters	**88**	7	**84**	28	**43**	12
Skidding distance (from carriage to logs)	meters	**30**	9	**30**	14	**12**	2
Average speed unload	m/s	**2,44**	0,75	**2,48**	0,71	**1,89**	0,62
Average speed load	m/s	**1,57**	0,36	**1,78**	0,56	**1,43**	0,43
Yield	t/min	**0,11**	0,07	**0,09**	0,06	**0,20**	0,26
Yield	m3/h	**6,81**	3,99	**5,11**	3,31	**11,76**	15,77

The number of cycles was this because all works are depending the weather conditions and planning of the forest company. More time was invested in Via Pian di Giuliano (A and B) because the company had more dedication and more forest to carry out the work, and the work (forest operations and monitoring) was accompanied by the weather.
The cable to skidding in place C was nearby from the carriage to worker, for this the time was shorter than other sites.
In general, in the place B the times were shorter by two things: some loads were large loads and the distance from the tower to carriage was shorter. And the great variability in yields is due to the fact that some loads were of dead or very light material. Because in chestnut forests, where the STSM was worked, you can find a lot of trees with fungi attacks (***Cryphonectria parasitica***)

Figure 7 Left carriage downing the skidding cable and right carriage uploading the trees (Navarro, P., 2017)

From disassembly and assembly

Disassembly:

Phase (figure 8)	time (min)
Down carriage	1
Remove the cable of the carriage	3
Recharge cable	15
Remove anchor points and recharge cables	14
Grouping elements to tractor (Cables, tower, anchors..)	5
Remove elements of the tower (the base, battens...)	7
Transport of the carriage and movement to other point	12
Total time	57

To disassembly the equipment is important two/three workers, and always the workers must ensure not problems with the cables (braiding between cables).

Figure 8: Disassembly of the equipment, up to the left downing the carriage, up to the right collecting the cables, down left removing anchorages and downright the equipment grouped.

Assembly:

Mounting tower in other point (figure 9)	time (min)
Positioning of the tractor and tower	10
Installation the base of tower	5
Installation of the tower (lifting)	3
Putting anchors	21
Installation of skyline	23
Testing the skyline	5
Mounting the carriage	2
Tauten	2
Testing the skyline and systems with carriage	1
Total time	72

Is important for the assembly the equipment to ensure all points of the tower and to have a good point to anchor the main line. The base of the tower must be in contact with the terrain on a steel plate. The anchors must be with specific angles regarding the tower, an anchor never should be straight line versus the tower. When the main line is mounted, a check must be carried out.

Figure 9 Up to the left the base of the tower (base plate), up to right position of the all equipment, down left mounting the tower, downright checking the main line and preparation of the carriage (Navarro, P. 2017).

7. Conclusions

The objective was to know the cable logging in coppice systems using an equipment adapted to Mediterranean conditions, similar than Catalonia or Spain. The objective has been fulfilled and in fact from this collaboration it could give the possibility of some study with this type of machine in Spain.

Regarding the tower, it is interesting to know the configuration versatility, a tower with tractor and independent tower with a motor. The size is optimal for mountain conditions because the forest workers can be work on small forest roads.
The carriages, both the 2.5-tonne 1.5-tonne, have interesting yields and can be useful in very high slope areas, in fact using the carriage of 1.5 tonne could be possible to load more than 1,5 tonnes (and has years of work).

The time to assembly and disassembly is shorter and this data is very interesting to optimise the forest works and preparation.

The main important thing is to have a plan for the works and to know the kind of forest, because if you have a specific forest where you can use this kind of logging systems, you can obtain a good result, without making a strong impact in the forest and improving the working conditions of people

8. Literature

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FIELD WORK (SITE 2)				nº workers:								
Nº CYCLE	Starting time:	Unloaded trip	Down cable for skidding	Loading	Cable rise	Loaded trip	Unloading	Nº trees	Distance (tower to carriage)	Distance (carriage to logs)	size of trees (diameter/length)	Other:
1												
2												
3												
4												
5												
6												
7												
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