

## Mechanized CTL Technology among Italian Loggers: Results of a Survey

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### Abstract:

*In the last decade mechanized cut-to-length (CTL) forest harvesting has increased significantly as a consequence of the need to address productivity, safety, environmental, and cost issues. However, the speed of its advancement varies depending on the country. In Italy, while the number of CTL machines is increasing, the majority of operators is still pondering whether they should acquire the new technology or stick to the old one. The objective of this study was to determine the attitudes of Italian loggers towards CTL technology, investigating their opinions and pinpointing real or perceived obstacles to its expansion. A survey was conducted during the 2011 edition of FORLENER forest machinery fair in Biella (Italy), one of the most popular events for forest mechanization in Italy. 90 Italian loggers filled out a questionnaire after interacting with a forwarder portable machine simulator. A sample of 44 valid questionnaires was selected to be included in this study analysis (only employers of logging firms were included in the analysis). Results show that Italian loggers are aware of the potential of mechanized CTL technology and of its benefits. Safety, processing time and ease of use resulted to be the most interesting features of mechanized CTL technology. Technical constraints (i.e. slope, branching) are considered secondary obstacles to CTL technology expansion. The main impediments to CTL technology expansion in Italy are financial.*

**Keywords:** CTL technology, firewood, Italy, harvester, processor, survey, questionnaire

### 1 Introduction

Originally developed in Scandinavia, cut-to-length (CTL) technology has fast grown worldwide in popularity, due to the need of efficient harvesting methods. CTL machines (forwarders and particularly harvesters) present a high degree of sophistication. In particular, harvesters are integrated with on-board computers specifically designed to automatically measure the length and the volume of the log, and to cut it at the most economical point.

Over the past few years the use of CTL forest harvesting, a completely mechanized system, has increased worldwide (Marshall and Murphy, 2003). In the Nordic countries almost all harvesting is currently done mechanically (Gellerstedt and Dahlin 1999). Its extensive diffusion is best represented by Finland, where in 2006 mechanized harvesting represented 98% of the total fellings of 50.8 million m<sup>3</sup> (Finnish Forest Research Institute 2007). Even in many Eastern European countries the traditional motor-manual methods is little by little losing ground to a mechanized system (Axelsson, 1998; Asikainen et al. 2009; Nuutinen et al. 2010). Nevertheless, the degree of mechanization varies considerably between countries (Divvela and Sinha, 2012).

Noteworthy is the case of CTL technology in Italy. The rugged terrain, the close-to-nature forestry and the prevalence of non-industrial private ownership slowed the introduction of mechanization process into the Italian forestry (Spinelli et al. 2009). However previous research gave evidence that despite structural and socio-economic constrains modern forest technology has recently made significant inroads in this country (Spinelli et al. 2009). Compared to northern European countries the number of Italian harvesters and processor fleet is still small, nevertheless they have the potential for growth. This is especially the

case in the northern part of the country, which hosts about two thirds of the national fleet (Spinelli et al. 2010; 2011).

It is worth remembering that a technology is useful to the extent that it improves production and profit and it is applied to the extent that it generates and satisfies users' needs. It has been established that CTL technology has the potential to increase efficiency and value gain from the whole forestry supply chain. However in Italy, while the number of CTL machines is increasing, the majority of operators are still at the window, pondering whether they should move and acquire the new technology or remain faithful the old one.

This paper focuses the attention on the issue of CTL technology expansion in Italy. In order to investigate this topic a survey was conducted during the most popular event for forest mechanization in Italy. The goal of the study was to determine the attitudes of Italian logging contractors towards CTL technology, pinpointing real or perceived obstacles to its expansion. Results of this study could be of great interest to machine manufacturers, especially to those who want to expand beyond Northern and Central Europe saturated markets.

## 2 Material and methods

The study was carried out during "FORLENER" forest machinery fair (2011 edition), the most popular event for forest mechanization in Italy, which attracts more than 10.000 visitors during three days event. Taking into account the peculiar environment in which the study was carried on, and the importance of collecting accurate answers from the people participating into the study, it has been decided to involve them into an activity before collecting their opinions. Due to time and costs constraints, a virtual activity on machine simulator (Figure 1) was made available to any visitors willing to try it. A 10 minutes (average) free trial activity on this portable machine simulator helped catalyzing people interested in the use and adoption of CTL technology. Moreover, it facilitated the collection of participants' views and opinions, as they were more willing to spend time communicating their point of view.



**Figure 1: Portable machine simulator**

The portable machine simulator was made available thanks to the collaboration between the CNR and the Centre Forestier de la Région Provence Alpes Côte d'Azur (Figure 1). It emulates the operations of a modern forwarder and was chosen over a harvester simulator because it was simpler to operate, an important requirements considering the environment limits of a fair. At the same time, it has the advantage of being more similar to the small scale forwarding units in use in the local territory.

### 2.1 The sample

During the three days fair event a total of 90 individuals participated to the study, and only those who were owners of a logging firm (employers) were selected to be included in this study analysis. Moreover, respondents who had less than 1 year experience in the field were removed from the sample, in order to

provide data based on a more informative sample. As a result, a sample of 44 valid questionnaires was collected and analyzed.

Since the event in which the survey took place was in the North of the country and that the survey participation was voluntary, the sample was unbalanced in terms of geographical origins (there were a larger numbers of Northern participants). Therefore geographical differences was not analyzed. At the same time only one female participated in the study, providing not enough data for gender differences analysis.

Table 1 gives a full description of the valid sample group selected for the study. No respondents were younger than 21 years old. Respondent between 37 and 46 years of age represented the largest group. Nearly two third of the respondents (63,6%) had been working in the forest more than 10 years, and were considered experienced professional loggers. Two third of the respondents deal with firewood. More than half of the sample (54%) worked both at felling and extraction, whereas one-third carried out a prevalent felling task.

**Table 1: Age and experience of respondents**

Age [years]	Number	%	Experience [years]	Number	%
21-26	9	20.5	1-4	8	18.2
27-36	13	29.5	5-9	8	18.2
37-46	15	34.1	10-19	15	34.1
>46	7	15.9	> 19	13	29.5
Total	44	100.0	Total	44	100.0

Non-parametric analysis were performed on the collected data. Given the ordinal character of the variables, the statistical significance of the eventual relationships between responses or between responses and sample demographics was tested with the standard  $\chi^2$  test for binomial comparisons, or with the Spearman Rho test ( $\rho_s$ ) for correlations (SPSS 2009).

## 2.2 The questionnaire

Data were obtained using a questionnaire designed to collect information about loggers' opinions on mechanized CTL technology. The questionnaire method was chosen as the best method to collect data, given the logistical constrains of this study.

The questionnaire consisted of a double-sided single page containing 13 close-ended and 2 open-ended questions. In the close-ended questions the respondents were asked to specify their level of agreement with a statement on a Likert-type scale ranging from 1 (do not agree at all) to 7 (fully agree). The questionnaire also contained a section for demographic data, where the respondents would specify age, provenance, occupation, years of experience and role within the enterprise. Additional space for comments was available in order to provide deeper insight into loggers' opinions. Each questionnaire took approximately ten minutes to complete.

## 3 Results

Results show that the loggers are aware of the potential of mechanized CTL technology and of its benefits. As reported in table 2, processing time in task execution (1) as been rated as the most important aspect in mechanized CTL technology. Safety (2) was rated as the second most interesting features of this technology. However, respondents judged this technology to be underused (3) and that the main obstacle to its expansion in Italy appears to be linked to the major initial investment cost (4). In comparison, running cost was considered less important (6) and it was generally not perceived as a limiting factor

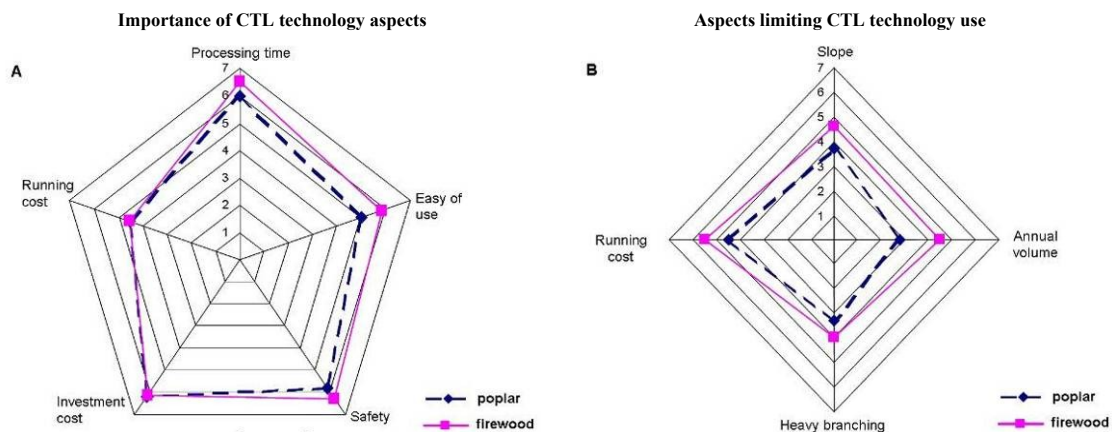
(10). Respondents opinions on the statement 13 were widely dispersed, showing that the respondents are divided on their willingness to use CTL technology, on these conditions, in the near future.

**Table 2: Agreement on statements about mechanized CTL technology**

#	Statement	Mean	SD	Min	Max
1	Processing time is important	6.5	1.0	1	7
2	Safety is important	6.4	1.3	1	7
3	It is currently underused	6.4	1.3	2	7
4	Investment cost is important	6.1	1.2	1	7
5	Easy use is important	5.7	1.7	1	7
6	Running cost is important	5.5	1.7	1	7
7	Slope is a limiting factor	4.9	2.5	1	7
8	Mechanized CTL is useful	4.6	1.7	1	7
9	Annual work volume is a limit	4.3	2.5	1	7
10	Running cost is a limiting factor	4.3	2.1	1	7
11	Heavy branching is a limit	4.2	2.5	1	7
12	Its use will increase	4.2	2.0	1	7
13	I would use it	3.4	2.5	1	7

Statements ordered for decreasing agreement: 1 = disagree, 7 = strongly agree.

An interesting comparison was made between respondents dealing mainly with poplar and those dealing mainly with firewood. As showed in figure 2.A their responses on the statements related to the important aspects in CTL usage overlap. They expressed the same opinion about running and investments costs, while marginal differences can be noticed on the other aspects. Loggers dealing mainly with firewood consider safety (M=6,3), processing time (M=6,5) and ease of use (M=5,8) as slightly more important than those dealing mainly with poplar (safety M=5,8; processing time M=6; ease of use M=5).



**Figure 2: Radar charts showing differences among respondents dealing mainly with poplar or with firewood on (a) aspects judged important in CTL usage and (b) factors limiting CTL use.**

On the contrary, differences in mean responses were found across all the statements related to the factors limiting CTL usage (figure 2.B). Indeed, the scanty volume of annual work, the slope gradient of the work environment, as well as the heavy branching and the machine running costs were considered as more limiting factors for those respondents working mainly with firewood (volume M=4,5; slope M=4,6; heavy branching M=4; running costs M=5,5) than with poplar (volume M=2,8; slope M=3,7; heavy branching M=3,3; running costs M=4,5).

Table 3 shows the result of the chi-square test (for a significance value of  $p=0.05$ ). Strong and obvious relationships has been found between age and experience (*Chi1*). Indeed, older people tend to be more experienced in the field compared to younger people. Similarly, a relationship between age and possibility of future use emerged (*Chi7*), showing that respondents from 27 to 47 years of old are those more keen to use CTL technology in the future. At the same time, younger respondents were those who dealt more with harvest firewood (*Chi3*). On the other hand, felling tasks was predominantly performed by respondents who believes that they won't use CTL technology in the near future (*Chi2*). Among the factors limiting the use of CTL technology, running cost is one of the most important for the most experience loggers (*Chi6*) and for those loggers mainly involved in extraction tasks (*Chi4*). At the same time, the annual work volume was considered by those involved in extraction as a factor not affecting CTL technology usage (*Chi5*). Indeed, in this case they reported verbally that their annual work volume was large enough to not be a limit.

**Table 3: Significant relationships between sample characteristics and statements and among statements**

#	Variable 1	Variable 2	$\chi^2$	df	p
Chi1	Age	Experience	40.8	9	.000
Chi2	I would use it	Felling task	22.8	6	.001
Chi3	Age	Harvest firewood	11.7	3	.008
Chi4	Running cost	Extraction	13.3	5	.020
Chi5	Annual work volume is a limit	Extraction	13.8	6	.031
Chi6	Running cost	Experience	26.1	15	.037
Chi7	Age	I would use it	29.0	18	.047

Statistically significant correlations between questionnaire statements have been found and reported in table 4.

**Table 4: Statistical correlation between statements**

	Statement 1	Statement 2	Stats
Rho1	Safety is important	Productivity is important	$\rho_s = .579$ , $df=42$ , $p<.000$ **
Rho2	Safety is important	Ease of use is important	$\rho_s = .345$ , $df=42$ , $p<.022$ *
Rho3	Age	Ease of use is important	$\rho_s = -.383$ , $df=42$ , $p<.001$ *
Rho4	Experience	Ease of use is important	$\rho_s = -.298$ , $df=42$ , $p<.049$ *
Rho5	I would use it	Ease of use is important	$\rho_s = .338$ , $df=42$ , $p<.025$ *
Rho6	Its use will increase	I would use it	$\rho_s = .451$ , $df=42$ , $p<.002$ **
Rho7	Mechanized CTL is useful	I would use it	$\rho_s = .337$ , $df=42$ , $p<.025$ *
Rho8	Mechanized CTL is useful	Safety is important	$\rho_s = .383$ , $df=42$ , $p<.001$ *
Rho9	It is currently underused	Running cost is important	$\rho_s = .357$ , $df=42$ , $p<.017$ *
Rho10	Annual work volume is a limit	Running cost is important	$\rho_s = .317$ , $df=42$ , $p<.036$ *
Rho11	Annual work volume is a limit	It is currently underused	$\rho_s = .315$ , $df=42$ , $p<.038$ *

\*Correlation is significant at the 0.05 level. \*\*Correlation is significant at the 0.01 level.

Respondents who thought that safety and productivity were important also believed that ease of use was one of the essential aspects in CTL technology (*Rho1*; *Rho2*). Among the study participants, those who gave more importance to the aspect of ease of use were the younger and the less experienced (*Rho3*; *Rho4*). A positive correlation has been found between those who thought that ease of use was important and the believe that they will use it in the future (*Rho5*). Participants who thought that CTL technology it is useful and will increase its presence in the Italian market were also more likely to declare that they would like to use it (*Rho6*; *Rho7*). Similarly, people who thought that mechanized CTL technology was

useful were also those who judged safety as an important aspect in CTL technology use (*Rho8*). Finally, it is worth noticing the relationship *Rho9-11*: people who thought that mechanized CTL technology was currently underused considered the machine running cost and the low volume of annual work as the factors limiting its adoption.

#### 4 Discussion

Cut-to-length mechanized system, is a popular alternative to conventional harvesting (LeDoux and Huyler 2001) and it has been established that CTL technology has the potential to increase efficiency. In Italy, forests cover 28.8 percent of the territory (Baldini and Pollini 1998), however numerous operators have not moved toward this new technology.

This study focuses on the issue of CTL technology expansion in Italy, investigating the attitudes of Italian logging contractors towards CTL technology, pinpointing real or perceived obstacles to its expansion.

Respondents believe that mechanized CTL technology is useful and that could be more applied in forestry than it currently is. The aspects of CTL technology that attract them the most are the benefits in terms of productivity and safety. The increase in productivity has always be a priory among loggers (Wester and Eliasson 2003), while the importance given to safety could be the results of the efforts made by the Italian Work Safety Administration to increase the awareness of logging safety issues (Montorselli et al. 2010).

Ease of use resulted very important for the younger participants and should be not overlooked. Indeed a positive correlation emerged between those who thought that ease of use was important and those who believe that they will use CTL technology in the future.

Survey participants are aware that CTL technology enables more productive and efficient utilization of wood, optimizes performance, as well as saves fuel and makes drivers' work easier. However the advanced technology content of CTL machines makes them very expensive, both in terms of purchase price and running costs (i.e. parts availability and technical expertise). Consequently, moving to mechanized CTL technology requires a solid amount of capital, which nowadays is the main obstacle to its expansion in the Italian market. Indeed, in Italy typical contractors are small companies which often have difficulties financing their purchase, particularly during such difficult economic times.

Under these circumstances, it may pay to develop specific CTL-implements for application to low-cost general purpose base machines. It is important however not to forget to focus on ease of use and safety aspects of those machines. Indeed, form the study it was possible to notice that one of the characteristics that were significantly correlated both with the opinions on CTL technology usefulness, desire of future use, and believe that its use will increase in the future was the easy of use.

Survey results could be of great interest to machine manufacturers, especially to those who want to expand beyond Northern and Central Europe saturated markets (Spinelli et al., 2011a). Indeed the advantage of this study is that is focuses only on employers in forestry sector, a potentially higher decisional power population, living out employees. If manufactures want to increase their sales in Italy they should target this sector of the forestry population and they should use this study results as a guide to product development, in order to offer dedicated versions that will best suit specific market sector (i.e. focusing on simplified low-cost machines).

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