

Safety and Prevention in Mechanised Forest Operations: a Tuscan Project

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Abstract

In the last years public and scientific debate about the reduction of polluting and CO2 emissions have intensified and the importance of renewable energies and fuel have increased.

At present many Italian logging companies produce substantial amounts of biomasses and forest operations are more and more mechanised. As a regard safety and prevention, the Tuscany Region has promoted in 2009 a project in order to provide specific guidelines to increase safety in logging operations and in particular in the use of harvester, chippers, cable yarders and other traditional machines.

Project partners are: CNR Ivalsa (National Council for research – Tree and Timber Institute), focusing on harvesters, processors and chippers; the University of Florence (DEISTAF Agricultural and forestry Engineering Dept.), for cable yarders; ISPESL (National Labor Safety and Health Agency) for general machine safety criteria and conformity of machines to European directives; the four provincial Health and Safety Agencies of Tuscany, for supervising the work and checking its applicability to Tuscan safety inspection programs. The primary aim of this project is to integrate the indications from the analysis of high mechanised forestry yards with the aspects of safety and prevention in forestry operations.

Keywords: biomass harvesting, high mechanisation level, risks profiles, best practices

Introduction

According to national Forest Inventory data (1998) Tuscany has a forest area of 1,086,000 hectares, representing 47% of the total territory of the region and over a tenth of the national one. The coppice exceeds the high forest, only in the mountain forests, particularly in beech woods, there was a strong increase (30%) of high forest. The privately owned is the type of ownership more frequent, with firms of small dimensions (70% of them have an average area less than 10 ha).

The forestry sector, directly and indirectly, involves about 9,000 workers (between technicians, operators, public enterprises, etc...). According to Chamber of Commerce Industry and Agriculture (CCIAA) data, in 2005 the wood enterprises were 1314 but this number is underestimate because it doesn't include those that work primarily in other

activities and occasionally in the forestry activities. According to ISTAT research, in 1990 the average number of permanent workers per forestry enterprises is between 1 and 2 units, so it is estimated about 2500 permanent workers but it's impossible to estimate the number of fixed - term workers engaged in the forestry sector because there aren't specific data. The last Report on the State of Forests in Tuscany (RAFT 2008) reports that in 2008 there was a large increase in the number of forestry enterprises (8.7% compared to 2007); this phenomenon can be caused by the new legislation, too (Legislative decree 81 / 2008); in fact some employers could have led some of their workers to take the P.I.V.A. (value added tax) so reducing their liability for occupational accidents, diseases and controls.

The forestry worker represents a high-risk category with high percentage of fatal and serious accidents; often, the statistic data about the occupational forestry accidents are inaccurate and incomplete because the enterprises are included in the "Agriculture Sector".

A thorough analysis of the various risks present during the forest utilization it has been addressed in a previous regional project which culminated in the production of the publication "Guidelines for prevention and safety in the forestry operations in Tuscany."

Recently with the developing of forest-wood-energy chain some enterprises have increased their level of mechanization by introducing innovative and complex machines; in consideration of this trend the need has sort to analyse in detail the risks profiles of these highly mechanized enterprises by activating a specific project called "Promoting Safety in the Forest - Wood-Energy chain", to prepare appropriate safety guidelines for mechanised operations. The project focuses especially on cable yarders, harvesters, processors and chippers.

The specific major objectives of the project are:

- Highlight any risks in using forestry machinery introduced recently in the yards of forest use to make more competitive the Forest-Wood-Energy chain;
- Provide specific references for the development of safety and health in the Forest-Wood-Energy chain through the definition of procedures and best practices really applicable by forestry workers;
- Promote the dissemination of good practices and procedures between the operators and the various actors in the sector.

Materials and methods

The project included four main steps: 1) an analysis of existing materials on safety in mechanized operations; 2) interviews with mechanized operators working in Tuscany, in order to draw from their specific experience and to gauge their awareness of specific risks; 3) direct observation of risk-taking behaviour in selected mechanized operations; 4) drawing the guidelines and disseminating them.

The work started with a thorough and accurate analysis of existing publications on the subject, including manuals, guidelines, popular articles and scientific articles. Overall, about 70 titles were collected and studied.

Meetings were organized with all the partners in order to develop a most complete and comprehensive ergonomics and safety checklist, to be used for interviewing mechanized operators. Before starting with the interviews, a general test of the questionnaires was conducted by the complete study group in three plenary inspections of mechanized operations. All partners together were then able to check the effectiveness of the questionnaire, and to introduce appropriate improvements.

In the questionnaire were considered:

- the logging company identification;

- the company structure;
- the types of machines used and their general analysis;
- the usual working process;
- the main tasks;
- the presence of the safety equipment on the yards;
- the operators experience;
- the operators risk perception;
- the operators rating;
- the risk analysis in the past and the near misses;
- our evaluation of the safety and wrong behaviour.

So far, 30 operators have been interviewed. Upon arrival to the worksites, operators were informed about the project and its goals, and were asked if they could devote some time to an interview, possibly during the lunch break or any other pause in the work cycle. Participation was voluntary and no compensations were provided.

The operations were also observed during regular work and were specifically sampled for risk-taking behaviour, using a dedicated data-collection form.

Results

During the interviews, we obtained data about 1) machine compliance to safety and ergonomics rules; 2) perceived hazards; 3) past accidents and near misses; 4) risk-taking behavior during work.

Evaluation of the machines

Harvesters and processors

The reference standard is the EN 14861: 2004 *Forest machinery - Self propelled machinery - Safety requirements* (August 2004). This document is a type C¹ standard as stated in EN 1070 and deals with all common significant hazards, hazardous situations and events of the following forestry machinery: fellers, bunchers, delimiters, forwarders, log loaders, skidders, processors and harvesters as defined in ISO 6814 and also multifunction versions of these machines, when they are used as intended and under the conditions foreseen by the manufacturer, see Clause 4.

The machines listed can be of the mobile, ride-on or self-propelled type or a combination of these types.

The following significant hazards are excluded:

- thrown objects, that may occur on a particular machine,
- noise,
- vibration.

In tab. 1 other reference standard for machinery for forestry

¹ Type harmonised standard can be:

- Type A standards, standards giving basic concepts, principles for design and general aspects that can be applied to all machinery;
- Type B standards, standards dealing with one safety aspect or one type of safety related device that can be used across a wide range of machinery;
- Type C standards, standards giving detailed safety requirements for a particular machine or group of machines.

Tab. 1 - other reference standard for machinery for forestry:

Standard	Type	Subject
ISO 6814: 2000	Machinery for forestry — Mobile and self-propelled machinery	Terms, definitions and classification
ISO 8082: 2003	Self-propelled machinery for forestry	Roll-over protective structures-Laboratory tests and performance requirements
ISO 8083: 2006	Machinery for forestry	Falling-object protective structures (FOPS) - Laboratory tests and performance requirements
ISO 8084: 2003	Machinery for forestry	Operator protective structures — Laboratory tests and performance requirements

The significant hazards associated with self-propelled, mobile and ride-on forestry machinery are:

1. Movement without a driver at the driving position
2. Falling or ejected objects;
3. Loss of stability/overturning of machinery
4. Objects falling onto or penetrating into the operator station;
5. Fluids ejecting from or rupture of unguarded pressurised hoses,
6. Slip, trip and fall of persons for lack, improper location or size of boarding means;
7. Contact with unguarded moving machine components, lack of clearance between moving parts;
8. Burns, scalds and other injuries by a possible contact of persons with objects or materials with extreme high temperature.

All checked machines complied with the main specifications for safety and were CE labeled, except for a very old chipper.

A main problem for excavator-base harvesters and processors was the coupling of head and carrier. In many cases, the manufacturer's handbook for the carrier did not specify the head types and models which could be fitted on the machine, which is a binding requirement of European safety law. Lacking such indications, owners should get their complete machine inspected and approved by ISPESL officials, which few had done.

Furthermore, windows on the excavators occasionally lacked suitable OPS. Where present, some of the OPS grates were too thick and impaired visibility.

As to machine self-evaluation, most operators were satisfied with the safety and comfort provided by their units. Negative appreciation only concerned the lighting and climatisation of excavator-base units. Old excavators often lack a functional air conditioning unit, and are only comfortable in winter time. A number of studies have documented productivity reduction in loggers exposed to the heat in warm climates (Smith et al., 1985, Hansson, 1968). Some operators reported that during the hottest summer days, the temperature inside the cabin

can be so high that they cannot work without keeping the doors fully opened and taking frequent rest breaks. On the contrary, just one of the operators using dedicated harvesters complained about the inefficiency of the a/c system.

Chipper

All checked machines complied with the main specifications for safety (CE label), except for a very old chipper.

Chipper operators occasionally complained about poor lighting. Lowest scores were attributed to dust and noise, mostly for chippers without an enclosed cab.

The reference standard is the EN 13525:2005+A1 (may 2007) *Forestry machinery - Wood chippers - Safety*. This document is a type C standard and specifies safety requirements and their verification for design and construction of transportable, i.e. self-propelled, mounted, semi-mounted and trailed, wood chippers used in forestry, agriculture, horticulture and landscaping. The standard EN 13525 applies to chippers, used when stationary, which are manually loaded with wood through a horizontal or near horizontal infeed chute at the end of which mechanical infeed components (or chipping components acting as mechanical infeed components) draw the wood into the machine. The included wood chippers may be powered either by an external power source such as a tractor power take-off, hydraulics, etc or by an integral power source such as an internal combustion engine or an electric motor.

The standard does not cover hazards arising from mechanical loading and shredders/chippers with integral power source and with or without vacuum assisted collection which are designed primarily to reduce organic material to smaller pieces to be covered by EN 13683 - Garden equipment - Integrally powered shredders/chippers – Safety.

Cable crane

Wood harvesting in mountain areas is often particularly difficult, due to terrain morphology. Cableways are in these circumstances the best choice, and the couple cableway plus processor is becoming more and more frequent in Italian forests (Hippoliti et al., 2000)

At the moment few people have a direct experience of operating with cableways and the needs of training courses are still high.

The main problem concerning safety in cable crane extraction operation is due to the several factors and components that are involved in the whole production chain (Kanzian et al., 2003). Indeed independently of the types of machine used the components assembly of the cable crane is one of the most crucial steps of the process and wrong mounted cable crane systems often occur in our forest (Marchi 1997).

The coupling of the several elements should be provided by the manufacturer’s handbook.

Also for cableways the checked machines complied with the main specifications for safety and were CE labelled. As to machine self-evaluation, all the operators were satisfied with the safety and comfort provided by their cable system.

Perceived Hazards

Harvesters and processors

First results hint at a higher perceived safety for operators working from a cab. For most, the main concern is represented by co-workers operating in the proximity of the machine – which have been often indicated as the primary source of work hazard. Many operators also reported on the need for safe behaviour during machine maintenance.

Maintenance and repair work is generally performed by the operator in the forest, outside the cab, often in difficult terrain and/or in adverse weather conditions. The main problems

reported for maintenance are related to: bad working postures; the need of great strength in handling heavy machine parts; the risk of slipping and falling associated with climbing up to and working on machines. Studies report that the accident rate for maintenance work is higher than that for machine operation, and nearly as high as in manual logging work (Vayrynen, 1984).

Chippers

Chipper operators using industrial machines generally work inside an enclosed cab, giving some protection against noise, dust and adverse weather conditions. Operators using small manually-fed chippers enjoy much less comfort and declare that they need to be very careful during feeding, because logs can “lash back” when they are engaged by the feed rollers. They usually wear tight clothes and use at least some of the prescribed Personal Protection Equipment (PPE), such as hearing protectors, gloves, goggles, and safety boots.

Chipper operators are particularly concerned with people entering the risk zone, and especially the loader swing area, the infeed area, the chip discharge area and the truck manoeuvring area. Many are also concerned with projection hazards, as the chipper can throw large wood chunks and occasionally metal parts, especially in case of mechanical failures. Preventive maintenance is carried out whenever the machines are stopped for knife changing. Both harvester and chipper operators perform all maintenance work with the engine is off, unless this must be kept running for locating a failure.

Cable crane

In cableway extraction, the operators must identify:

- suitable stacking points;
- rack layout in relation to landform;
- the availability of spar and support trees especially in thinning operations.

A high hazard perception for the workers often occurs during loading and unloading operations under the line. Unloading is considered as the primary source of work hazard, but also maintenance and wire rope handling are often dangerous operation.

The main problems reported are related to the mounting and dismounting process of the cable crane, to climbing operations needed to prepare intermediate supports and to the risk of slipping on the forest ground during loading (Fabiano et al., 2001). Also bad postures were noticed during loading operations.

Moreover operators are particularly concerned with people entering the risk zone, and especially under the line during extraction and at the landing for unloading.

They usually use at least some of the prescribed Personal Protection Equipment (PPE), such as gloves and safety boots but the periodical use of the helmets in the risk area was noticed.

Direct observation of risk-taking behaviour

Very few real accidents have been reported, while some near-misses were described and commented.

So far, different operators were observed several hours each for risk-taking behaviour. Violations to safe working practice were characterized and annotated, obtaining a frequency distribution of different risk-taking behaviours, which can be related to time, number of events and output.

Harvesters and processors

With harvesters, the most frequent observed violation to safe working practice consisted of working with open doors, always pertaining to excavator-base machines and generally depending on the absence of an efficient a/c system. Some operators also stated that they preferred to work with open doors in order to obtain better visibility. All knew this is unsafe practice, but they deemed heat stroke and poor visibility to be higher risks. Many operators also did not use seat belts, although all machines were equipped with them. Finally, some operators mounted and dismounted by jumping, even if all machines were provided with suitable steps.

Chippers

Observation of chipping operations yielded similar results to those listed above, with the most common violations pertaining to open doors and lack in the use of seat belts. In one case, we also observed maintenance being conducted without gloves, which entails the risk of wounding and/or contamination with potentially hazardous fluids and chemicals.

Cable crane.

As regard cable crane systems the setting up and safe operation require a well trained working crew that is capable of recognising conditions that could potentially lead to failure, such as weak stump anchors, unusual line stresses etc. Technical guidance to avoid cable system failures is often available in the form of operating manuals. However, their application often depends on the knowledge and the skill of each individual crew. Using a specific data collection protocol the violations to safe behaviour were investigated.

In cableways extraction operations, the most frequent observed violations to safe working practice consisted of wrong cableways and bracing mounting and wrong loads hooking. Some operators often work without Personal Protection Equipment especially at the landing and they usually don't pay a careful attention to the wire rope maintenance.

Discussion and conclusions

With the Legislative decree n. 81/2008 s.m.i in terms of prevention and worker safety all workers are required to attend specific training courses managed and defined by their companies.

None of harvester, chipper and cable crane operators have attended a formal training program, but just few days in coincidence with the delivery of the machine, by the manufactures. Most relied heavily on a combination of "on the job training" and experience gained in the logging or other similar previous works. This lack of training appears to be primarily due to the high daily production demands necessary to keep the operation profitable. Therefore, nobody is willing to leave his/her workplace for more than a week, because the missed income would be too significant.

Training is essential also to allow crews to efficiently operate cable systems. Focused training such as crew productivity training for entire crews, with emphasis on how the actions of individual crew-members may influence the productivity of the entire team.

Even experienced operators benefit from refresher training. It is important that the machine and system are equipped with ropes and components in a serviceable condition, that meet the manufacturer's recommended specification. The weight of the load must not exceed the

manufacturer’s recommended safe working load, which must be clearly stated on the machine.

Attention to work safety is motivated by a number of different considerations, deriving from ethics, self-preservation and legal obligations. However, it also has a further dimension in economics, because less accidents mean less lost workdays, and therefore less revenues for both the employer and the employee.

Safety and ergonomics are closely related, because an uncomfortable operator can get too tired and lose concentration, which makes he/she more prone to engage in risk taking behaviour. At the same time, productivity also declines, with the increased risk of machine and product damage.

Most of the loggers interviewed during the study have a very clear perception of the risk inherent to their work, they may occasionally engage in risk-taking behaviour, as we observed during our study. Once asked about the specific events observed, most answered that they knew they were violating safety prescriptions, but they were confident in their own experience, and in their capacity to control the work process.

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