

Safety aspects in the use of agricultural tractors

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Abstract

The Italian legislative decree of April 9, 2008, No 81 established a series of obligations for the employer (Article 71) and the self-employed (Article 21), that request the implementation of measures ensuring that work equipment is properly maintained, in order to ensure the continuity of the safety requirements of Article 70 and the correct keeping and update of the audit log. The purpose of this paper is to provide organizational solutions and/or procedures capable to support the industry in the verification and maintenance of safety requirements for agricultural or forestry tractors intended as work equipments. 27 agricultural tractors, different per class of power, mass and type of propulsion (22 wheeled and 5 tracked tractors), have been examined. Through a series of detailed and targeted inspections, the main shortages and non-compliances have been identified. A plan for the adjustment and the correct management of the machines has been activated with the aim of raising the level of safety during the work and of protecting the physical integrity and the health of the workers. During the inspections, checklists have been adopted, referring to the main tractor components. The results of the audits show that 15% of the inspected tractors lacks a protective device in case of overturning. As to the driver's seat, 29% is in excellent conditions, 15% is sufficiently preserved, while the remaining 56% is in poor conditions. 74% of the seats has no seatbelt. As regards the protections from mobile and hot elements, 41% of tractors has no guard against accidental contacts.

Keywords: maintenance, control, driver safety

Introduction

The legislative decree of 09 April 2008, no. 81 and subsequent modifications and additions, established a series of obligations on the employer (Article 71) and the self-employed (Article 21) which also include the implementation of measures necessary to ensure that the agricultural and forestry tractors are being properly maintained over time to ensure the permanence of the safety requirements of Article. 70 and the care for the keeping and updating of the control register. The purpose of this paper is to provide organizational solutions and/or procedures that support the operators of the sector (employers and self-employed) in the verification and maintenance of safety requirements of agricultural and forestry tractors, considered as work equipment, in accordance with the requirements of the article 71, paragraph 4, letter a) point 2, letter b) of Legislative Decree 81/08.

Materials and methods

37 agricultural tractors were examined, different for power class, mass and type of propulsion units (29 wheeled and 8 tracked tractors). As to the registration year, in 5 cases it was not possible to obtain such an information and the corresponding circulation certificate. The remaining 32 tractors were registered between 1960 and 2010, with the distribution described in Fig. 1.

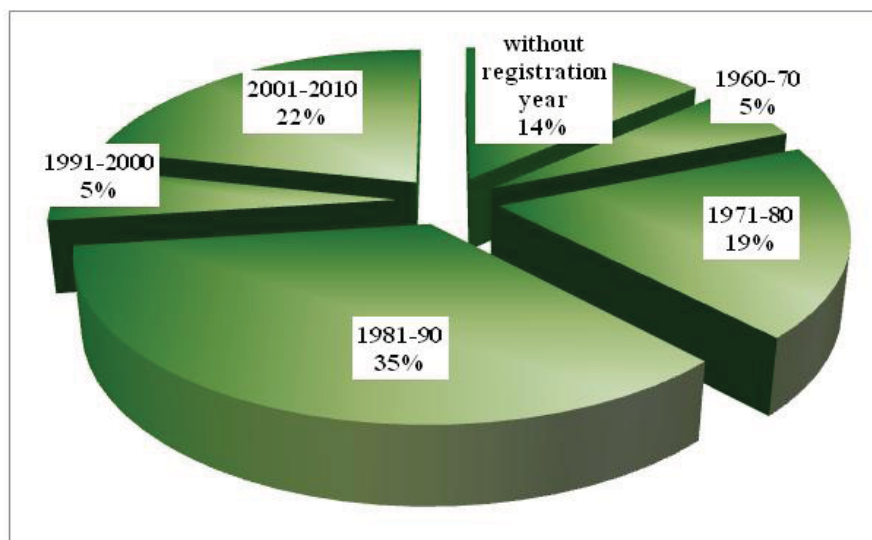


Figure 1. Division of the tested tractors by year of registration

Through a series of detailed and targeted surveys it was possible to identify the main deficiencies and non-compliance. Then, an adaptation and management plan started in order to raise the safety standards under work conditions and to protect the physical integrity and health of the workers. During the inspections, checklists were used, derived from technical standards normally used in the process of construction of new tractors, and related to the main parts of the machines. The topics dealt in the checklists were the following: technical data and documentation of the tractor; presence of pictograms; access to the cockpit; controls; lighting and signalling devices; rear-view mirror; propulsion and support; protective device in case of overturning; the driver's seat and restraint system; protections of moving parts; protections of hot parts; electrical equipment; tubes and hydraulic jacks. The topics listed above are not exhaustive of all the safety requirements needed in agricultural tractors. The subjects were excluded from the survey, although of fundamental importance for the safety of the operator: state of efficiency of the braking system; correct operation of the lighting system and of the visual and audible warning systems; inhibition of the engine start with gear and/or PTO inserted; correspondence between tyres' size and the details on the registration certificate.

Results

Access to the driving position

The access to the driving position must be secured by means of a suitable ladder to avoid any danger of slipping and falling for the operator. The ladder must have the platforms fitted with a device to prevent foot slipping. Moreover, handles and/or handrail must be present in order to ensure always three points of contact. Finally, all parts of the means of access and their attachment points to the tractor frame must be in good condition and, in particular, must not have breaking points, permanent deformations or corrosion that may compromise their structural functionality (Fig. 2).



Figure 2. Left: access to the driving position without handle. Right: ladder platforms with evident corrosion and deformation

Commands

A command is any device enabling to change the status or the operation of the tractor or of the equipment connected to the tractor (paragraph 1.2 of Annex I to Directive 86/415/EEC). The commands of the tractor movements must be designed to automatically return to the initial position, after the release. In addition, they must be located outside the danger zone and must be preserved by the intervention of unauthorized persons. When the operator leaves his seat, he must use protective shields or key operated switches.

The controls are commonly of visual type and are designed to verify that the commands and their engagement lights (indicating that the device is operating) are reliable and that the phenomena of wear of the components do not affect the reliability of the command, mainly in order to avoid accidental grafting of those commands directly connected to the safety (eg. controlling the PTO, front or back hydraulic lift, etc.). Among the 37 inspected tractors, only one showed problems in the command/controls.

Lighting and light signalling devices

The tractor shall be fitted with the following lighting and light signalling devices:

- parking lights and rear red reflected light devices;
- white or yellow (or white and yellow) low beam light;
- blinking light indicators of direction;
- red stop lamps;
- white front and red rear outline marker lamps for tractors of exceptional dimensions;
- number plate lights;
- additional blinking devices with yellow or orange light must be available when the tractor circulates under exceptional conditions or with equipments.

In this case, the inspection regarded the presence of breaks and/or damages on the light sources, on the bright surfaces (parabolic structures, mirrors), on the supporting frames (lighthouse cans, glasses, etc.), indicators of grafting and operation, electric system (Fig. 3).



Figure 3. Example of tractor with broken lighting devices

Rear-view mirror

The inspection on the rear view mirror had exclusively visual nature and aimed at verifying their state of preservation (the mirror should not have lost its original properties of reflection, should not be dull, broken, etc.) and the correct anchoring and positioning on the tractor (the supports, the arms and the articulation system of the mirror must not be loosened) (Fig. 4).



Figure 4. Example of tractor without rear view mirror.

In the chart of Fig. 5 the following devices are considered: access to the driving position (ladder platforms, handles and/or handrails), lighting and visual signalling devices and rear view mirror. For each of them, the label reports the number of tractors equipped with it on the total of 37 tractors inspected.

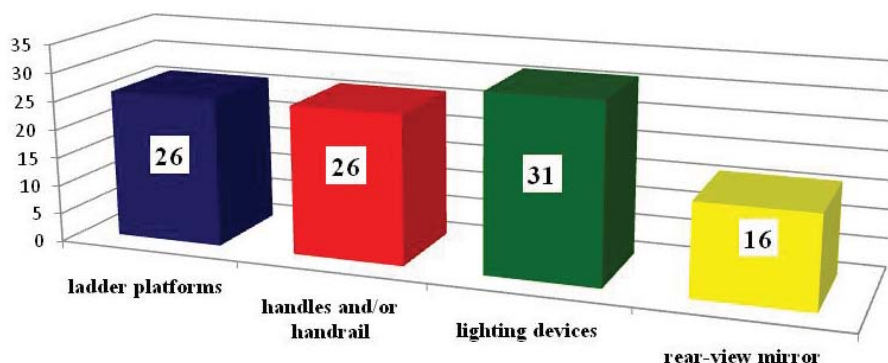


Figure 5. Results of the inspection on the 37 tractor of the devices for the access to the driving position, of lighting and light signalling devices and of rear view mirrors.

Protective device in case of overturning

All agricultural and forestry tractors, with wheels or tracks, must be equipped with a protective device in case of overturning as cab or frame (ROPS), to ensure an adequate "safety volume" surrounding the driver's seat with the aim of keeping the operator inside it during the entire phase of overturning. In this way, the risk for the operator to be crushed between the constituent parts of the tractor and the soil can reasonably be ruled out. The protective structure must always be suitably labelled. The label must be visible and report information about the compliance of the safety frame with the safety requirements.

The checks carried out on ROPS devices were exclusively of visual type. In particular, they regarded the following aspects: presence of corrosion in progress; presence of cracks detectable by visual analysis (Fig. 6).



Figure 6. Left: protective frame with evident signs of corrosion in progress. Right: four-post frame without identification label. The points of anchorage to the tractor frame are in poor condition.

In the graphs of fig. 7, the various types of protective structures (cab, frame) present on the 37 tractors are taken into consideration. Finally, in the presence of a protective structure, the presence of suitable label was examined.

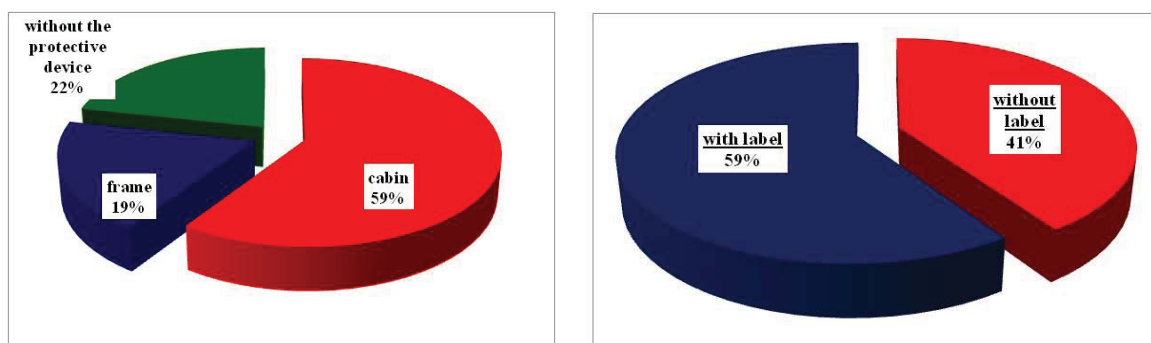


Figure 7. Left: type of protective frame against overturning on the 37 tractors. Right: presence (59%) or absence (41%) of metallic label

Driver's seat

The driver's seat is a seat available for a single person identified as the driver when driving the tractor (point 1 of Annex I to Directive 78/764/EEC). The driver's seat must be in possession of general and specific requirements identified in Chapter 1 and 2, respectively, Annex II of the said Directive (Fig. 8).



Figure 8. A seat intact, equipped with a system of retention of the driver (seat belt).

The checks on the driver's seat are aimed at ensuring over time the maintenance of technical and functional characteristics of the seat and of the seat belt. In addition, the belt must not have frayed, torn, heavily worn areas, or tampering, failures and unoriginal seams. The seat must be firmly anchored to the frame of the tractor and must be intact. It must not have any failure or breakage in its frame, padding, and in the eventually present systems for vertical and longitudinal adjustment and for shock absorption (suspensions) (Fig. 9).



Figure 9. Examples of driver's seats with damaged padding and without seat belt

In the charts of Fig. 10, the seats of the checked tractors are classified using the following evaluation criteria:

- good: no sign of failure or breakage in the structure and padding, perfectly intact;
- sufficient: some sign of weakness or failure in the structure and padding;
- poor: serious evidence of subsidence and cracks in the structure and padding.

Moreover, the presence (or absence) of seat belt has been verified.

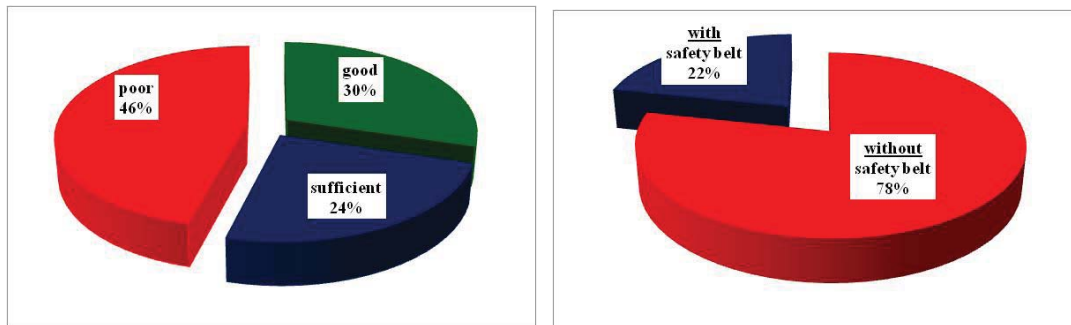


Figure 10. Left: classification of the seats of the 37 checked tractors. Right: presence (22%) or absence (78%) of seat belt.

Propulsion and support (tyres, tracks)

Visual checks on the tyres of tractors under study were intended to verify that their wear were such as to ensure the safety during tractor driving. From the point of view of safety, the wear of an agricultural tyre becomes critical when at any point of the tread, the original design (lugs) is no longer visible, with the resulting consumption of the rubber located in the bottom of the notches.

As to the tracks, the checks were focused on the structural integrity of the chain and of the shoes bolted on them.

Protection of mobile elements

The moving parts of the tractor that potentially represent a source of danger in the event of unintentional contact are (Fig. 11): the power take-off, the belts for the transmission of the motion, the fan of the cooling system, the driving shaft transmitting the motion to the front wheels.

The controls are visual and are intended to ensure that both the technical and functional characteristics of the protections originally installed by the tractor manufacturer and the protections installed later as a result of adaptation to the safety requirements set out in paragraph 6, Part I, Annex V of D. Decree 81/08, are maintained over time. The controls aim at verifying that said protections are firmly attached to the tractor and that their structural parts and points of anchorage to the tractor are in good state, not broken, without permanent deformations and corrosion that could affect the characteristics of structural resistance.

Protections of hot parts

The outer surface of some parts of the tractor can reach temperatures above 80° C, with a consequent risk of skin burns. Such parts may be external surfaces of the components of the exhaust gas system (silencer, collector) and of the engine (cylinders and heads) (Fig. 11). The inspection, only visual, aims at verifying the technical and functional characteristics of the guards installed, their correct anchorage to the tractor (screws enough tightened, anchor points intact), the good condition of all their structural parts that, in particular, must not be broken, with permanent deformations or corrosion that may compromise the structural resistance.



Figure 11. Left: transmission shank without any protective shield or shelter covering the terminal outlet of the PTO. Centre: the transmission belt of the fan and large part of the engine compartment do not have protections against accidental contacts on both sides. Right: a pipe for exhaust gas without protection against accidental contacts. It is located very close to the access to the tractor cab

The chart of Fig. 12 reports the results of the inspection on tyre wear, protection of the PTO, guards of the transmission belts, protection of the cooling fan. The numbers on the labels indicate the tractors equipped with such devices among the 37 examined tractors.

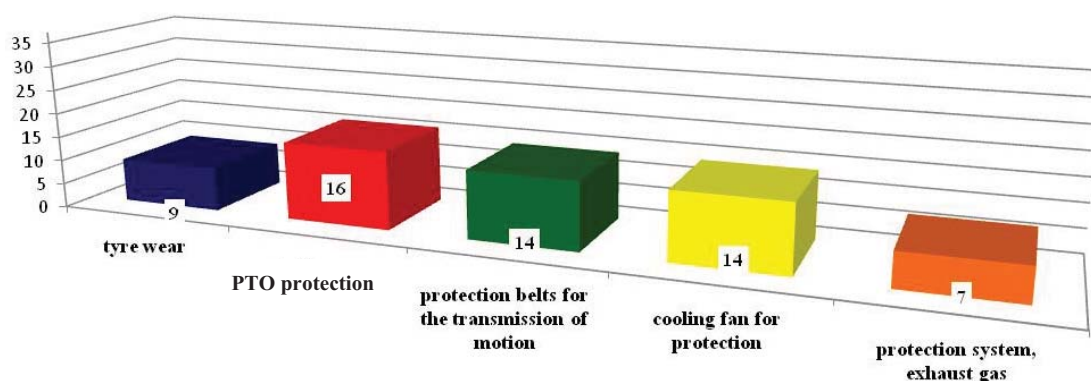


Figure 12. Results of the inspections on tyre wear (left) and on the protections of: PTO, transmission belt, cooling fan, exhaust gas system.

Conclusions

The issue of safety in the workplace strongly emerged in recent years because of the high frequency of accidents, sometimes very severe, affecting various productive sectors of our country. The agricultural sector is one of those at highest risk because of the frequent use of mechanical equipment to which severe and highly frequent accidents are connected, in addition to a series of occupational diseases that are often not recognized as such. One of the major contributors to such risks, in Italy, is represented by the composition of the machinery fleet, where the presence of machines older than 10 years is predominant. The injury statistics (INAIL), relating to agriculture, show that the tractor is mainly responsible for 10% of the accidents occurred and for 35% of fatal accidents.

As regards the mode of occurrence, although no significant statistical data are available, the greatest risk for the operator is certainly represented by the transverse and/or longitudinal

overturning of the tractor, caused by excessive slopes, overloading, excessive towing load, abrupt manoeuvres. The analysis of results shows that several of the inspected tractors have no seat belts (78%) and have rather old and worn seats (46%). In addition, 22% of them is devoid of protective device in the event of overturning (cab or frame), capable of ensuring an adequate safety volume in correspondence of the driver's seat. As the risk of overturning is intrinsic in the use of agricultural tractors, it seems appropriate that its consequences are analyzed and evaluated already in the design and construction phases and not only during the utilization, thereby protecting the product end-user.

References

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Legislative Decree 27 January 2010, n. 17 implementation of Directive 2006/42/EC on machinery and amending Directive 95/16/EC relating to lifts.

UNI EN ISO 4254-1 Agricultural machinery – Safety - Part 1: General requirements.