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Agricultural Health and Safety Survey in Friuli Venezia Giulia

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Abstract: The work in the agricultural sector has taken on a fundamental role in the last decades, due to the still too high rate of fatal injuries, workplace accidents, and dangerous occurrences reported each year. The average old age of agricultural machinery is one of the main issues at stake in Italy. Numerous safety problems stem from that; therefore, two surveys were conducted in two different periods, on current levels of work safety in agriculture in relation to agricultural machinery's age and efficiency, and to show the levels of actual implementation of the Italian legislation on safety and health at work in the agricultural sector. The surveys were carried out, considering a sample of 161 farms located in the region Friuli Venezia Giulia (North-East of Italy). The research highlights the most significant difficulties the sample of farms considered have in enforcing the law. One hand, sanitary surveillance and workers' information and training represent the main deficiencies and weakest points in family farms. Moreover, family farms do not generally provide the proper documentation concerning health and safety at workplaces, when they award the contract to other companies. On the other hand, lack of maintenance program for machinery and equipment, and of emergency plans and participation of workers' health and safety representative, are the most common issues in farms with employees. Several difficulties are also evident in planning workers' training programs. Furthermore, the company physician's task is often limited to medical controls, so that he is not involved in risk assessment and training. Interviews in heterogeneous samples of farms have shown meaningful outcomes, which have subsequently been used to implement new databases and guidelines for Health and Safety Experts and courses in the field of Work Safety in agriculture. In conclusion, although the legislation making training courses for tractor operators and tractor inspections compulsory dates back to the years 2012 and 2015, deadlines have been prorogued, and the law is not yet fully applied, so that non-upgraded unfit old agricultural machinery is still being used by many workers, putting their health and their own lives at risk.

Keywords: work safety; health and safety; risk prevention; risk assessment document; ROPS; safety belt

1. Introduction

In the last decades, the theme of safety at work in the agricultural sector has taken on a fundamental role. Following the 'Tractor Directive' in Italian law on Safety at work (Italian Law 81/2008)—agricultural tractors are currently equated to work machines, the principles of safety at work, ergonomics, and protection of the tractor operator and the other passengers [1,2].

Agricultural tractors in Italy are estimated in 1.7 million units, 35% of which are older than 44 years of age and 50% of which are older than 25 years of age [3]. This is a considerably critical issue in the field of road traffic and safety at work.

Despite many projects and awareness campaigns concerning the issue of safety in agricultural activities, conducted particularly by the National Institute for Insurance against Accidents at Work, vehicles, being non-compliant and potentially fatal in the event of an accident [4–6], are still present in farms and on the market. Many case studies [7–10] show that tractors lacking essential safety requirements-like seat belts and Roll Over Protection Systems-can cause fatal accidents in case of roll-over of the vehicle [1].

Accidents caused by and with tractors are statistically one of the most frequent causes of death in agriculture [1,11,12].

In Italy, the underestimation of this phenomenon has been observed for many years; in fact, only accidents involving farm employees were registered as 'occupational accidents' until 2014, while those involving semi-professional operators were considered as 'domestic accidents' [1].

According to a recent study on serious accidents in agriculture in Friuli Venezia Giulia (North East of Italy), an estimated rate of 30% cases are not surveyed or investigated [1,3]. Considering only the deadly accidents in agriculture and forestry operations, concern arises, as 51% of these accidents happened while workers were operating tractors (75% located on field and 25% while driving on roads) [4,13,14].

As far as accident dynamics are concerned, machine rollover represents 77% of accidents, while accidents involving the cardan shaft account for 0.7% only, but 66% of cases result in the death of the operator [15,16].

According to the reconstruction of 60 fatal accidents with tractors (northeast Italy) [2,11], the origin of these accidents can be categorized into three types:

- Technical causes (set of lacking safety elements)
- Causes of a human or behavioral nature (improper use of the tractor). In this regard it should be stressed that the legislation does not provide the private use of the tractor, it must always be linked to the cultivation or the forest; this is a factor that is often missing in the use of such equipment, in fact, as shown in the analyzed data in five cases the tractor was used in non-agricultural contexts and with playful purposes (race of tractors, carnival parade, loading and unloading of building material, and transport with tractor of building vehicles) [2,11]
- Structural failures (within the analyzed cases, some of them are related to the failure of embankments, bridges or ditches) [2,11].

However, it should be stressed that in the reconstruction of the dynamics, often there is not only one cause but the fatal accident is derived from a human error combined with the use of an unsafe vehicle. [2,11,12].

Within the European Community and according to Italian norms, there is currently a decisive indication by the legislator to make the use of agricultural tractors more professional and more responsible in considering other sectors as the plants to energy conversions and agro industrial [11,12,17–21].

Since 2012, with the 'Technical Law' bill, a specific professional training for the use of this type of machinery has been implemented as mandatory—an obligation that is still to be fully extended within the Italian territory [15,19,22].

In the light of such considerations, this study is meant to investigate a representative sample of the real conditions of the tractors within farms, aiming at bringing to light the main criticalities and proposing effective systems of analysis that can be used by the agricultural entrepreneurs themselves, to improve the present situation.

2. Materials and Methods

A first-level analysis was conducted to assess safety levels on a sample of 103 agricultural farms, with a prevalence of dairy farms and farms with vineyard and/or horticultural crops (Table 1).

Table 1. The sample farms in the first survey.

Type of Farm	No.	%	Average Size (ha)
Dairy farms	36	35.0	67.5
Other livestock	17	16.5	89.9
Vineyard and winery	24	23.3	55.6
Horticulture and nursery	12	11.7	9.4
Other	7	6.8	14.9
Mixed	4	3.9	240.5
Cereal crops	3	2.9	42.3
All farms	103	100.0	63.9

These farms were located in all of the six Health Districts in Friuli Venezia Giulia, each controlled by the respective District Agency. Part of these farms (56.3%) employed hired personnel, while 43.7% were family farms, allowed by the law to use a simplified safety management scheme.

Each farm was visited by one evaluator, and all data were recorded following a specific questionnaire. This questionnaire covered two main areas of interest (Figure 1):

- area A, including general information about the farm;
- area B, which varied depending on farm specialization, and was further divided into three profiles:
    - B1: farm machinery;
    - B2: personal protective equipment (PPE);
    - B3: specific risks.

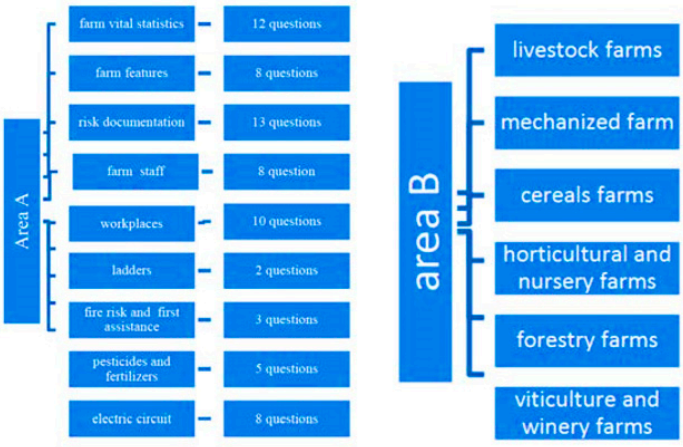

Figure 1. Specific questionnaire.

A second-level analysis was performed on a sample of 58 agricultural tractors (Table 7), employed in 11 selected farms, with the objective of further analyzing the presence or absence of legally required protective items. All main protective equipment and safety systems', as mentioned at point 2.4 part II of Annex V of the Italian Law number 81/2008, were checked and evaluated for compliance with the law. This included roll-over protective structures, safety belts, protections of moving parts, and other items (reported in Table 9).

3. Results

To the purpose of the first study, we analyzed:

- whether official documents and records were actually present at the farm;

- how safety management was organized;
- the working environment in the farm (useful element to correlate machine use and safety);
- the presence of protection devices on tractors;
- the use of prevention and protection equipment.

3.1. First Level Analysis

Table 2 includes only 58 farms with external personnel, which are subjected to full application of Italian Law 81/08, including official documentation. The main document required, i.e., the Risk assessment document, was absent or inadequate in 34.5% of the farms; other required documents were even more often missing, including a scheme for medical surveillance of workers (34.5%), the scheme for emergency procedures (41.4%), and the record of periodic inspection of lifting equipment (44.8%).

Table 2. Official documents at the farm.

Type of Document	Missing or Inadequate (% of Farms)
Risk assessment document	34.5
Risk assessment update	44.8
Medical watch	34.5
Emergency procedures	41.4
Regular inspection record (lifting equipment)	44.8
Compliance certificate of equipment	10.3
Book of use and maintenance	8.6
Pesticide license	24.1
Pesticide safety sheet	25.9
Equipment maintenance plan	36.2

Only those documents provided by third parties were mostly present, such as the Compliance certificate (lacking in 10.3% of farms), the Book of use and maintenance of equipment (8.6%), the Pesticide safety sheet (25.9%), or those required for purchasing pesticides (Pesticide license: 24.1%). Particularly remarkable was the absence of a plan for machinery and equipment maintenance (in 36.2% of farms), because of its great importance for accident prevention.

The Italian law also requires every farm with hired personnel to officially appoint a number of figures in charge of the different protection and prevention services (Table 3). While a safety manager (or head of the prevention and protection service, PPS) was mostly present (82.8% of the farms), other figures were often missing, including a doctor designated for periodic medical surveillance (48.1% of farms), or the supervisors for fire prevention (33.3%), first aid (34.6%) and workers' safety during work (63.0%). Additionally, 38.3% of the farms were not providing the workers with sufficient training and information services, while 44.3% did not have any special training for the various managers and supervisors.

Table 3. Managers and services.

	Not Present (% of Farms)
Safety manager	17.2
Medical doctor	48.1
Fire prevention manager	33.3
First-aid manager	34.6
Workers' supervisor	63.0
Training and information service (workers)	38.3
Special training service (managers)	44.3

Most of the farms had adequate toilet and shower services and dressing rooms for the workers (Table 4). The width of the main entrance to the farm (minimum: 5 m) was mostly in line with the law.

However, protections on gaps or trenches were missing in 28% of the farms. Most remarkable was the absence of any Interference risk analysis, i.e., a plan to avoid risks owing to the presence at the farm of external personnel, especially contractors for cereal or grape harvesting. Only 8.6% of farms had conducted a proper analysis of such risks.

Table 4. Situation of buildings in the farm.

Building Services	Yes (%)	No (%)
Toilets	93.9	6.1
Showers	87.2	12.7
Dressing room	86.4	13.5
Main entrance to farm > 5 m	81.3	18.6
Railing on hole, trench	71.8	28.1
Interference risk analysis	8.6	91.4

In approx. one half of the farms, a specific analysis was made to assess the main features of the tractors (Table 5). The average nominal power was 63 kW, and the average age was 20.9 years. The average annual usage (328 h/year) was related to the small average land area (63.9 ha, Table 1), and was far from the level suggested for profitable management (at least 600 h/year). These data offer some clues as to the current difficult economic situation in most of the farms: the reasons are many, and they cannot be fully discussed here. Nonetheless, this makes it even more difficult for these farms to bear the costs involved by current requirements for risk prevention and protection.

Table 5. Tractors at the farms.

	No. of Tractors	Power (kW)	Age (years)	Usage (h)	Usage (h/year)
Dairy farms	54	76.6	20.7	7339	355
Other livestock	18	65.6	21.6	7078	328
Viticulture	62	57.1	15.3	4444	290
Horticulture and nursery	26	50.3	27.8	3610	130
Other	2	40.4	24.8	1750	71
Mixed	29	61.8	26.1	15329	588
Cereal crops	5	64.7	20.0	6958	348
All farms	196	63.1	20.9	6873	328

In fact, missing protection devices are mostly related to the tractor's old age. In most of the sample farms, tractors were equipped with roll over protection structures (ROPS), protection of moving parts, such as belts and fans, and of hot surfaces (Table 6). However, a safety belt was missing at the driver's seat in 55.1% of the tractors—even though it has been declared mandatory since 2005. PTO (power take off) guards were also missing in 24.7% of the tractors (the study has analyzed in a different and specific way the part of the PTO, as it is often the cause of fatal accidents).

The relationship between the presence of protective items and the tractor's age is shown in Figure 2. All of the new tractors were in line with legal requirements, the only exception being the safe access to the driver's seat; Italian law requires the presence of two handles and stairs for tractors that have a distance exceeding 0.55 m from the ground (Annex V of the Italian Law 81/08) but this is often difficult to attain especially in small tractors for viticulture. This means that the main problem for these farms is the low investment capacity, which makes it difficult for farmers to replace old tractors with new ones.

Figure 3 shows the percentages of farms providing their workers with personal protection equipment (PPE). In general, only basic PPE were present (like cotton overalls and mechanical protection gloves), while specific PPE were seldom found (such as ear muffs, safety foot-ware, chemical resistant clothing and gloves and chemical resistant respirators).

Table 6. Protective devices.

Protective item	Missing (% of Tractors)
ROPS	5.2
Safety belt	55.1
Protection of belts & fans	7.6
Protection of hot surfaces	10.8
Safe access to driver seat	13.6
PTO guards	24.7
CE marking (European Conformity)	37.6
Owner handbook	8.0

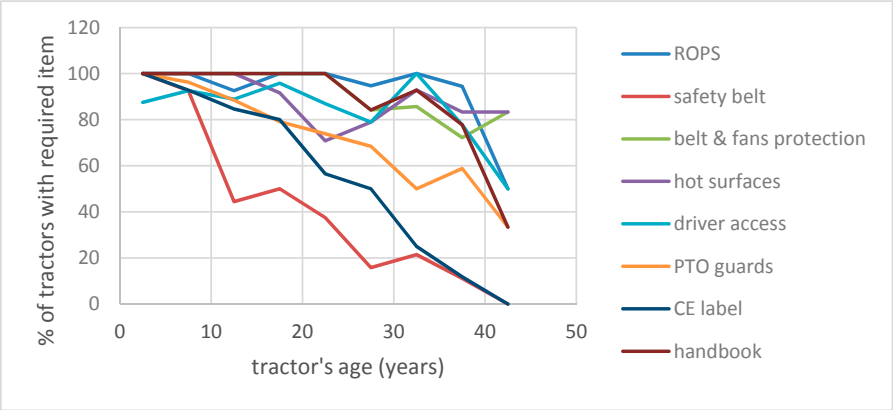

Figure 2. Tractors with required protective items in place.

The main findings from the survey suggested that several agricultural farms were sufficiently aware of the risks associated either with their specific production systems, or with the machinery used, to some extent, particularly in order to avoid the related economic costs. More importantly, information about legal obligations was generally poor, as was the understanding of the possible cost, in terms of fines, damage compensations etc. which failure to comply with the rules might cause.

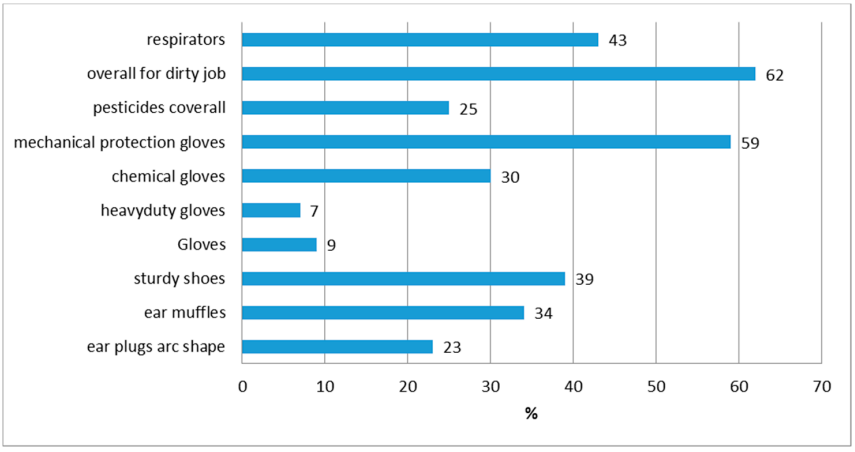

Figure 3. Types of personal protective equipment (PPE) provided at the farms (% of farms where present).

This suggested that most farms would take advantage of some simple informative tool, e.g., in the form of a software, to quickly detect the most critical situations. This software, based on a Microsoft Excel® worksheet (Figure 4a), enables the farmer to check all of the legal requirements for tractors and the main agricultural implements, and suggests how to amend possible defects.

For instance, it is possible to examine the existing ROPS on a tractor (Figure 4b), and understand whether it fulfills legal requirements or it needs changes or replacement; furthermore, indications may be given on how to install a ROPS on an old tractor.

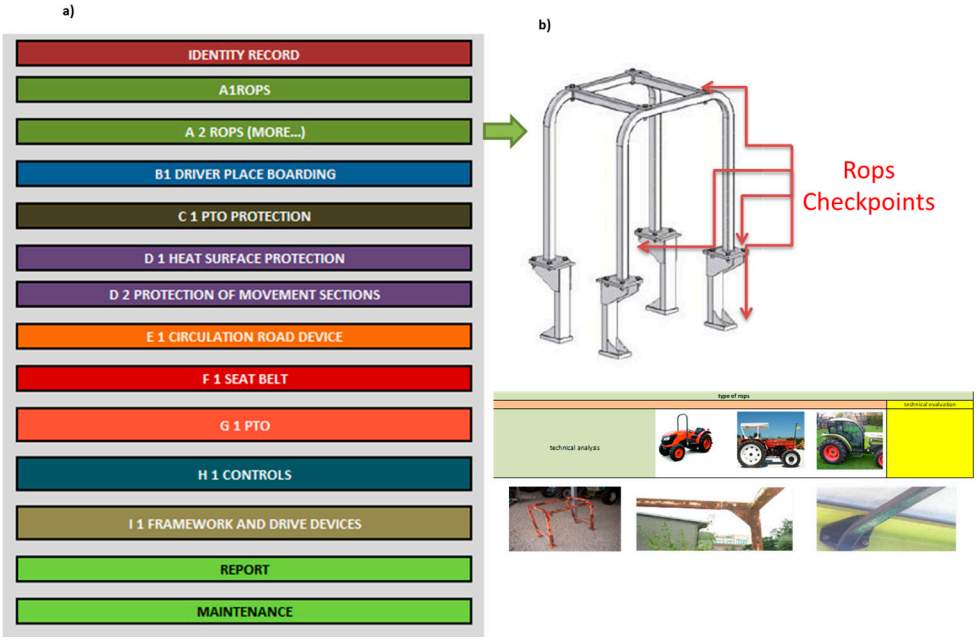

Figure 4. Extract from the software designed for the analysis of the tractors (**a**), (**b**) specific ROPS (rollover protection system) control areas.

3.2. *Second-Level Analysis of the Sample Based on 11 Farms*

The second survey investigated three groups of farms: vineyard farms, cattle and cereal farms, and a third group of mixed farms (Table 7). This involved an overall number of 58 agricultural tractors.

Table 7. The sample farms in the second survey.

Farm	Type	Own Area, ha	Managed Area, ha	Managed Area, ha
1	Vineyard	180	180	18
3	Vineyard	15	30	4
5	Vineyard	50	50	4
8	Vineyard	5	5	2
	Vineyard farms			28
2	Cattle and Cereals	50	200	5
4	Cattle and Cereals	60	80	5
11	Cattle and Cereals	20	70	3
	Cattle & Cereals Farms			13
7	Cereals and Contractor	300	450	7
6	Orchard	5.8	5.8	2
9	Mixed	50	250	5
10	Market garden	2	3	3
Total		738	1324	58

In the vineyard sector, the mean age of tractors was lower (5728 total h and 14.2 years) compared with both the Cattle % Cereals group (8046 h and 25.2 years) and with the average of the remaining

farms (8557 h and 24.3 years) (Table 8). On the other side, the annual use is higher in the vineyard sector (502 h/year, versus 351–370 h/year).

Table 8. Second survey: Tractors power, age and usage.

Type of Farms	Vineyard	Cattle & Cereals	Other	All
Rated power, kW	56	59	65	59
Age, h	5729	8046	8557	7078
Annual usage, h/year	502	351	370	429
Age, years	14.2	25.2	24.3	19.6

The fact that agricultural tractors in the vineyard sector are generally of a younger age implies that they have minor problems in terms of safety and efficiency. In fact, this particular agricultural sector is generally more proactive and prone to invest financial resources, mainly because companies have a higher profitability but also because they are normally larger and therefore more structured and less family-owned. This shows a clearer perception and higher awareness of safety issues and needs (Table 8). Nonetheless, the present study also highlights some extremely important negative features, which can be of paramount importance in implementing corrective measures for the upgrading of current agricultural machinery inventories. In fact, farms dealing with working areas of more than 50 ha extension have been recognized as having the oldest agricultural tractors-with an average age of 25 years.

The main lack is in the power take-off guards (34.5%), followed by driver's seat belts (24.1%), together with lack of hot parts protective shields (32.8%). Lack of moving parts protections (20.7%) and ROPS (19%) has also been highlighted by the study (Table 9).

Table 9. Compliance with safety requirements (% of all tractors). Study-derived technical analysis.

Item	Evaluation	Yes	No
Documents	Compliant	69.0	31.0
PTO guards	Compliant	65.5	34.5
Moving parts, protections	Compliant	79.3	20.7
Hot surfaces, protection	Compliant	63.8	32.8
ROPS	Compliant	81.0	19.0
	Present	98.3	1.7
Driver's seat	Compliant	50.0	50.0
	Type conform	69.0	31.0
	Undamaged	75.9	24.1
Handles	Compliant	72.4	27.6
	Present	77.6	22.4
	Type compliant	74.1	25.9
	Size compliant	72.4	27.6
Stairs	Compliant	84.5	15.5
	Present	94.8	5.2
	Size compliant	84.5	15.5
Safety belt	Compliant	67.2	32.8
	Present	75.9	24.1
	Own installation	22.4	
	Own installation, certified	8.6	
Tires	Compliant	69.0	31.0
	Type compliant	82.8	15.5
	Undamaged	77.6	22.4
Mirrors	Compliant	69.0	31.0
Lights	Compliant	75.9	24.1

Tractor's compliance with the law (% of required items that were indeed present) was analyzed versus the tractor's age (in years) and the type of farm personnel (farms with and without external, hired workers, respectively). Both regressions in Figure 5 were statistically significant (R^2 = 0.383 and R^2 = 0.453, respectively), showing that: in general, the percentage of compliant items decreased with increased age of the tractors; in particular, tractor compliance was lower in family farms independently of the tractor's age. This can be explained by lower perception of risks in family farms, which certainly represents a failure of awareness campaigns conducted so far, but may also be related to the smaller economic size of these farms, and to the difficulty of bearing the costs involved by extensive equipment updating so as to meet the current requirements for risk prevention and protection.

Figure 5. Tractor's compliance (% of compliant items) vs. tractor's age (years) in farms with or without hired personnel.

4. Conclusions

This research work shows that the situation of safety in the agricultural sector is still a real cross-cutting issue, mainly due to three aspects:

- low perception and awareness of the issue of safety at work by the workers in the agricultural sector; in fact, even if the machines are technically obsolete and unsafe, there is the tendency not to sell or adjust the machine, which is considered as a potentially useful vehicle or one that can be used in case of emergency.
- non-economical difficult interventions to upgrade machines having mainly a non-productive, affective value; in fact, very often the agricultural entrepreneur does not want to discard his own machine since the tractor is linked to a memory of a missing family member or parents.
- ineffective control system (e.g., [3,8,10,13,20–22]).

With the introduction of a rapid and efficient control system, this study wants to propose an operational instrument enabling the farmer to analyze the farm machinery and to put into practice simple modifications or installations that in the case of an accident or tipping of the machine could mean saving his/her life. The instrument could also be an excellent guideline not only for the agricultural world but also for the workshops that are only currently approaching the problem of the adjustment of agricultural machinery.

Moreover, the study only concentrated on the harmonized safety standard for the tractors improved safety for operators, such as physical exposure to ergonomic hazards. In fact, operators loading the machines are prone to musculoskeletal disorders since they often undergo awkward

postures, repetitive movements and frequent lifting of loads. For this reason, further studies in this matter in particular could prove useful.

In particular, this study highlights the fact that, although the legislation making training courses for tractor operators and tractor inspections compulsory dates back to the years 2012 and 2015, deadlines have been postponed and the law is not yet fully applied.

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