

A Survey on Fatal Accidents for Overturning of Agricultural Tractors in Italy

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The government agencies that are responsible for labour safety frequently delay the publishing of the figures of the accidents occurred in agricultural sector, including those caused by the overturning of tractors. This is due to the time required to conclude the investigation of each fatal event. The elimination of this delay may not be possible. Thus, the statistics do not satisfy the requirements of effective surveillance of the trend of overturning accidents to implement prompt actions to increase safety.

Many web portals have been created in these last years to support weekly or daily newspapers at the local level. A fatal accident due to a tractor overturning is considered to be a significant occurrence. Thus, from 2008 a web observatory was created to determine the current situation of accidents involving tractors that overturned. This method had a significant advantage for obtaining the trend of the statistics related to the main details of each event practically in real time, such as the age, gender and nationality of the victims; the month, day of the week and location of the accidents and the characteristics of the involved machinery.

Eight hundred seventy-three fatal accidents were processed in Italy during the survey period. As expected, the average age of the victims was quite high (62 years old). 68 % of the overturning accidents occurred during field operations, and 32 % occurred during transport operations. Eighty-six percent of the fatal events occurred on slopes, but above all ROPS (Roll Over Protective Structure) protection was missing from 61 % of the involved tractors. In the majority of the cases, the tractors were old machines that did not operate in accordance with general and specific safety labour laws.

1. Introduction

In order to maintain safe operations, organisations must continuously review and monitor their risks. This means that the results of safety studies must be translated into a format that can be analysed, reviewed and acted upon, and new data about the level of risk continuously collected to keep the safety information up to date (Balfe et al, 2014). Fatal accidents that occur in agricultural environments frequently involve machinery and vehicles such as tractors. In particular, the injuries from an overturning accident can be prevented by Roll Over Protective Structures (ROPS). In many countries, authorities have imposed this type of protection on tractors for many years (Springfeldt, 1996). The Scandinavian countries were the first group of countries to issue mandatory regulations and obtain encouraging results: in Sweden, the frequency of fatal rollovers per 100,000 tractors per year decreased from 17 to 0.3. The frequency of fatal rollovers decreased in the previous decades in many countries: in Norway from 24 (in the period 1961-1969) to 4 (1979-1986); in Finland, from 16 to 9 from 1980 to 1987; in West Germany from 6.7 to 1.3 (1961-1986).

An analysis of 202 agricultural tractor fatal injuries (presumably, the majority involved overturning) that was conducted in Georgia (USA) for the period of 1971-1981 concluded that fatal injury rates increased with age for the examined population. Persons whose primary occupations were not farming accounted for more than half of all tractor-associated deaths. Fatal injuries occurred throughout the year but predominantly during the planting and harvesting months. Injuries occurred throughout the day (7 a.m. to midnight), with a peak from 4 p.m. to 5 p.m. The majority of fatal injuries (76 %) occurred after tractors overturned (Goodman et al, 1985).

Many of the accidents that occurred during agricultural activities are not officially recorded for many reasons. A comparative study of 388 fatal accidents related to agricultural machinery occurred in Spain from 2005-2010 concluded that only 61.9 % of the deaths were regularly reported. Older people comprise the social group with

the highest risk; however, children and non-farmers should be carefully considered. Based on 272 reported fatal overturning accidents, the main cause of death was the lack of a ROPS on the tractor; only one accident involved a tractor that was equipped with a homologated ROPS. Many accidents occurred while tractors were operated along roads and tracks. Terrain conditions such as slopes, ditches and obstacles are also considered to be important risk factors. A total of 11 risk factors have been characterised; the concurrent involvement of at least two risk factors is frequently required to cause a fatal accident. The majority of accidents are caused by the overlapping of 3 or more risk factors (Arana et al., 2010).

1.1 Situation in Italy

The fitting of new conventional tractors with ROPS has been compulsory in Italy since 1974. In the following decades, this requirement has been gradually extended to other tractor categories (narrow-track and crawler). Since 1981, the issue of the "used tractor" (i.e., tractors sold prior to 1974) was addressed; however, the problem was not definitively resolved until 2006 with the issuance of the guidelines "Fitting of ROPS in case of rollover of agricultural or forestry tractors" (*Installazione di dispositivi di protezione in caso di ribaltamento nei trattori agricoli o forestali*) by the National Institute for Insurance Against Accidents (INAIL), which contains detailed instructions for the manufacturing and fitting of ROPS on all used tractors. The strength of the ROPS is verified using a series of loading tests, which are specified in dedicated standards issued by international organisations (EU, OECD, ISO and SAE) (OECD, 2017). The aim of this paper is to offer an original chance for improving the surveillance on the trend of fatal accidents due to the overturning of the agricultural tractors, in order to implement prompt actions to increase safety, by using the information contained in the web portals. The main assumption is that a fatal accident due to a tractor overturning has certainly sufficient relevance to be reported on the web portals, at least in the area in which the event occurred.

2. Materials and method

In the early 1970s, the statistics of the government agency responsible for labour safety (INAIL) were reporting an official figure of 200 fatalities per year due to overturning of agricultural tractor that were officially recognized and compensated. Currently, INAIL reports an average of 25-30 deaths per year caused by the same reason. Surveys from different sources reveal number of fatalities much higher. This large discrepancy is attributed to the notion that the compensation for injuries (fatal or nonfatal) is typically related to "professional workers". In fact, also INAIL estimated that in 2010 almost 164.000 injuries were "invisible" (not reported to the authority), due probably to the position of workers without formal labor contracts and thus without public insurance of their health (Vignoli et al, 2014).

However, in agriculture, the operation of tractors on a secondary basis by an extensive variety of non-professional workers (family members and relatives of the owner, seasonal workers, etc.) is quite common. The official mode of the recording, classification and management of these events produces dynamics that do not facilitate prompt and updated monitoring on a national scale. The consensus is that a real situation is different and the consideration of alternate solutions may enable a real overview of these situations.

2.1 The role of the Web

The Web has recently changed with regards to the approaches used to communicate information. Many international, national, and local portals were established to systematically report news that has relevant significance (Blogspot "Caduti sul lavoro", 2017). Thus, a fatal accident at work, such as a tractor overturning with one (or more) victim(s) will not go unnoticed even if is not mentioned by the press at a national level, as it will be reported on local web portals (of regions, municipalities, local TV, newspapers and news sites) and on numerous blogs. From these premises, all fatal accidents that involve the overturning of agricultural tractors and that occurred in Italy from 2008 to 2014 were detected on the Web and classified based on the following set of conditions: month, day and location of the accident; age, sex and nationality of the victim; task performed at the time of the accident; type of tractor and ROPS involved in the accident; characteristics of the accident site. The primary added value of the method is that it enables monitoring of the accidents with an acceptable approximation, maximum timeliness and a reduced commitment of resources. Moreover, to obtain more information about the possible causes and working conditions of accidents occurrence, when suitable this information was compared with some data drawn from the most recent Italian Agricultural Census, made in 2010. It seems appropriate to take into account the data coming from this Census, because they have been registered within the period of the accidents detection.

However, the adopted method has some limitations as follows: cannot be exhaustive, as the obtained statistics show values that do not completely reflect reality; cannot be systematic, as the details of the reported events are not completely congruent; may be subjected to possible inaccuracies reported by the press.

3. Results and discussion

Considering the entire 7-year period, a total of 873 fatal overturning events were investigated, with an average of approx 125 accidents per year, ranging from a minimum of 109 fatal overturnings in 2008 and a maximum of 148 accidents in 2011 (Figure 1). Thus, a detailed analytic description of the collected data may be useful to highlight possible critical points that caused the accidents.

3.1 Month of accident

As expected, a high number of fatal events occurred during spring and summer, being this the period in which the major part of agricultural activity in the open field is performed (Figure 2). The figure for May in particular is impressive; as an average, more than 17 fatalities were recorded in the month; if only the working days are considered, it means approx one death a day. As expected, in the winter months the figures are low, but in March, at the beginning of the agricultural activity in Italy, a total of 58 fatalities were registered. The statistical analysis (conducted considering the single year) confirmed the significance of the number of the fatalities occurred in winter, but revealed the variable number of fatal overturnings occurred in spring and summer.

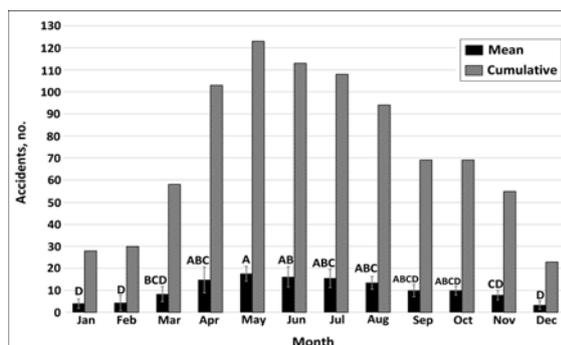
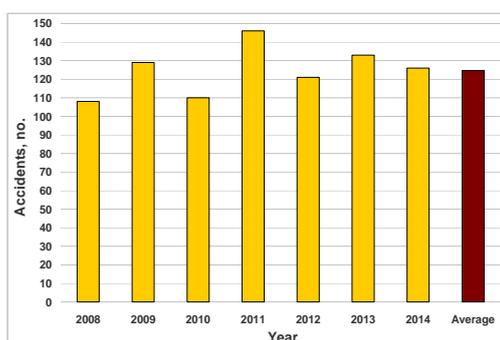


Figure 1: Fatal overturning accidents occurred in Italy involving agricultural tractors from 2008 to 2014.

Figure 2: Monthly trend of occurrence of fatal overturning accidents involving agricultural tractors in Italy from 2008 to 2014.

3.2 Day of accident

The progressive increase of physical and mental fatigue, which reduces the level of attention and surveillance, has been considered to be one of the causes of accidents. Therefore, an increase in overturning accidents during the latter part of the week with a substantial decline over the weekend can be expected. On the contrary, the statistics revealed an indistinct trend (Figure 3): Tuesday and Saturday seem to be the most dangerous days of the week, but similarly on Monday and Thursday the occurrence of these events was high. It has been surprising to detect that many accidents also occurred in Saturday, so noting that for farmers the weekend is not considered to be a free time, especially when urgent tasks must be completed as soon as possible due to uncertain climatic conditions. The high number of recorded accidents during the weekend is also attributed to the nonprofessional and part-time manpower as their field activity is primarily conducted during their free time. In addition, their skill levels and the tractor maintenance conditions driven by them are generally poor.

3.3 Region of accident

The fatal accidents total number occurred in each region is shown in Figure 4. For a detailed analysis these figures have been compared with the Utilized Agricultural Area of each region, as reported in the Italian Agricultural Census carried out in 2010. The regions where farming is prevalent (Sicily, Puglia and Sardinia) are not those most affected by fatal accidents. In fact, the ratio fatal accidents/UAA (Figure 5) revealed that Liguria (approx 27 accidents/100,000 ha) and Abruzzo (approx 16 accidents/100,000 ha) were the most dangerous regions. On the other hand, a considerable part of UAA classified as hill and mountain leads to the consideration of a large area of sloping terrain. In principle, this seem to be a factor increasing the overturning risk. Abruzzo, Liguria, Marche, Molise, Trentino Alto Adige, Umbria and Valle d'Aosta have all their UAA classified as hill or mountain. So, the ratio values of fatal accidents/100,000 ha of hill and mountain were calculated (Figure 6): the Veneto resulted the most dangerous region, with 40 fatalities per 100,000 ha of hill and mountain recorded from 2008 to 2014.

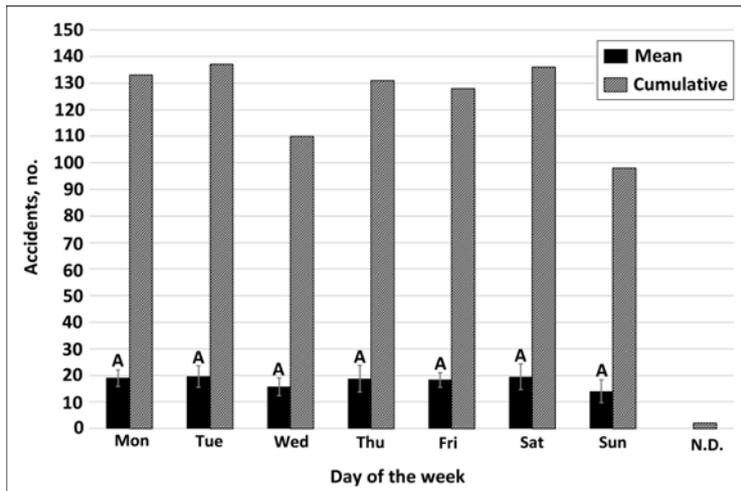


Figure 3: Trend of fatal overturning accidents involving agricultural tractors in Italy from 2008 to 2014, considering the day of the week of occurrence (N.D. = Not Detected).



Figure 4: Absolute number of fatal overturning accidents involving agricultural tractors in Italy from 2008 to 2014, considering the region of occurrence.

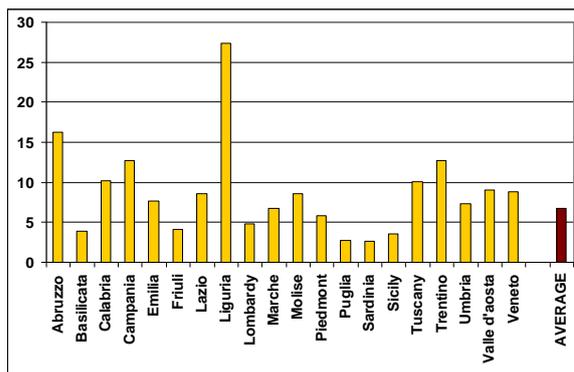


Figure 5: Fatal overturning accidents involving agricultural tractors per 100,000 ha of UAA in Italy from 2008-2014, considering the region of occurrence.

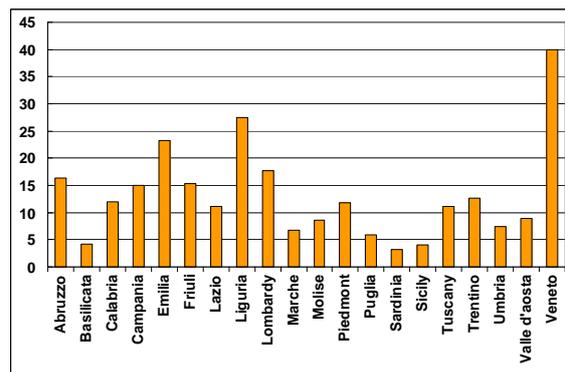


Figure 6: Fatal overturning accidents involving agricultural tractors per 100,000 ha of UAA of hill and mountain in Italy from 2008-2014, considering the region of occurrence.

3.4 Age, gender and nationality of the victims

The average age of the victims in the 873 fatal overturning accidents surveyed is 62 years old. As expected, the age increases more than proportionally with respect to the number of deaths (Figure 7). The majority of the victims were 65 years and older (67 % of fatal accidents). The considerable ageing of the manpower involved in agricultural tasks is the main reason for this trend. In addition, the oldest farmers frequently drove the oldest tractors (the most dangerous tractors), on which the wear level is significant and the maintenance is generally poor. The data also indicates some fatalities involving boys younger than 18 years old. They were partly drivers and partly extra drivers, these last travelling presumably with an adult, such as the father or another relative. In 859 of the 873 total fatal accidents that were investigated, the occupant was a male; the data indicates that presumably few women drive a tractor in Italy. As expected, the majority of the victims were Italians (96.2 %); among foreigners, 14 victims were from Romania. The poor language skills of especially non-EU operators represent a common obstacle in understanding and applying the proper safety instructions for reducing the risk level when driving a tractor. In a few cases, the overturning accidents involved more than one person: in 25 events (4.1 %) two people died; one accident involved 3 victims.

3.5 Labour amount

Apart the terrain characteristics, the fatal overturnings could be interestingly compared with the manpower workdays. The Italian Agricultural Census of 2010 revealed that the manpower is composed in great part by the farm owner and his/her family; the employee represents a quite small part of the persons working in agriculture. Seasonal persons are on average 11.4 % of the total manpower. For each region the ratio fatal accidents/100,000 hours worked was then calculated (Figure 8). Once again, Abruzzo was the region showing the highest value (10.5 fatalities/100,000 hours worked). Apart the sloping terrain, for Abruzzo, Umbria and Valle d'Aosta also for the hours worked is confirmed the high risk in occurring an overturning accident.

3.6 Location of accidents

Although the majority (68 %) of the fatalities occurred during field activity, 32 % of the accidents occurred on the road (18 % on farm roads and 14 % on public roads, presumably in traffic conditions). This finding demonstrates that also transport can be considered to be a dangerous task. In the case in which a tractor overturned on roads open to traffic, the involvement of other vehicles cannot be excluded and injuries and/or fatalities of other road users is a possible consequence of accidents.

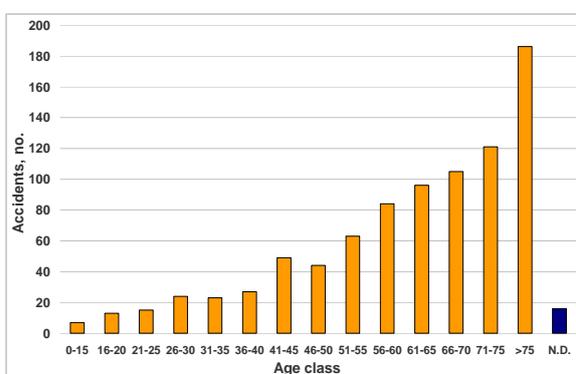


Figure 7: Age of the victims in fatal overturning accidents involving agricultural tractors in Italy from 2008 to 2014 (N.D. = Not Detected).

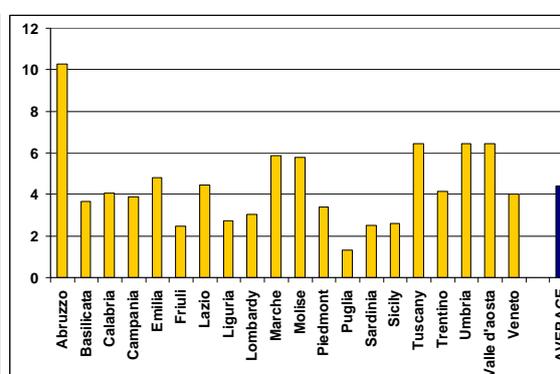


Figure 8: Fatal overturning accidents involving agricultural tractors per 100,000 hours worked in Italy from 2008 to 2014, considering the region of occurrence.

3.7 Terrain characteristics of accident

Due to inadequate descriptions of accidents, the terrain conditions were only ascertained in 44 % of the cases: 234 accidents occurred on slopes, which is approximately 6 times greater than the number of accidents that occurred on flat surfaces (37). As expected, the poor stability of the tractor and its implement when working in hilly conditions is a fundamental factor of overturning.

3.8 Type of tractor and ROPS involved in the accident

The information source lacks data about the type of ROPS fitted on the tractors that are involved in fatal overturning accidents. Unfortunately, these data were only obtained for 36 % of the accidents. However, in approximately 61 % of these cases, the tractors were not equipped with ROPS. In 39 % of the remaining cases, the most common types of ROPS were the 2-post front-mounted folding rollbar (25 %) the cab (11 %), the 4-pillar frame (2 %) and the 2-post rear-mounted roll-bar (1 %).

Considering only the overturning accidents that involved tractors equipped with a 2-post front mounted folding roll-bar, the roll-bar was determined to be in a horizontal position, which assures no protection, prior to the fatal event in 80 % of the cases. This finding represents a quite critical condition, that requires urgent improvements, i.e. in the (manual or automatic) operation of the foldable roll-bar.

Tractors equipped with a safety cab (equipped with a ROPS) were involved in only 10 % of the fatal accidents. Due to the high level of protection assured by a safety cab in the case of overturning, the death of a driver was most likely caused by multiple rollover of the tractor (sometimes combined with an implement). This conclusion demonstrates that the fitting of a ROPS can considerably improve the safety level in the case of overturning. However, note that absolute protection can never be guaranteed.

4. Conclusions

Recent official statistics report approximately 25-30 fatalities per year for tractor overturning, whereas surveys on the Web reveal about 110-140 deaths per year, which is 4-5 times higher than the official data. The fatal accidents do not highlight a positive trend despite an intense effort by the authorities and agencies responsible for work safety in agriculture. Some actions have been implemented to improve the situation, such as dedicated guidelines issued by INAIL (the main Italian national agency responsible for work safety) for the mandatory fitting of ROPS and an appropriate retention system for the driver (seat belt) (INAIL, 2008), on old (INAIL, 2009) and special tractors (conventional, narrow track, crawler and transporter) (INAIL, 2012), which were not previously addressed by previous laws and regulations. In addition, renewal of tractor fleets may considerably improve the safety level, not only with regards to the overturning risk. Farmers and their labour organisations are strongly requesting public and effective financial support for scrapping obsolete tractors. Another obstacle in the reduction of fatal overturning accidents is the old age of the tractor drivers. The manpower in the agriculture sector is decreasing and ageing; young people are not encouraged and adequately supported to perform agricultural tasks. Non-EU operators can be a valuable resource provided that they are able to acquire proficiency in the Italian language and can be properly trained in operating complex machinery. An important factor in the improvement of the safety level could be the institution of the periodic check of agricultural machinery (primarily tractors), which should commence soon in Italy (INAIL, 2011). The skills of tractor drivers have recently become regulated: young professionals who operate tractors must attend a specific driving. To maintain a tractor license, all drivers will be required to periodically attend a refresher course.

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