

Tractor accidents in Swedish traffic

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Abstract. The objective of this study is to reach a better understanding of accidents on Swedish roads involving tractors and to suggest ways of preventing them. In an earlier study we analyzed police-reported fatal accidents and accidents that led to physical injuries from 1992 to 2005. During each year of this period, tractors were involved in 128 traffic accidents on average, an average of 7 people were killed, 44 sustained serious injuries, and 143 sustained slight injuries. The number of fatalities in these tractor accidents was about 1.3% of all deaths in traffic accidents in Sweden. Cars were most often involved in the tractor accidents (58%) and 15% were single vehicle accidents. The mean age of the tractor driver involved was 39.8 years and young drivers (15-24 years) were overrepresented (30%). We are now increasing the data collected with the years 2006-2010 in order to study the changes in the number of accidents. Special attention will be given to the younger drivers and to single vehicle accidents. Based on the results we aim to develop suggestions for reducing road accidents, e.g. including measures for making farm vehicles more visible and improvement of the training provided at driving schools.

Keywords: Farm vehicles, injury, prevention, road accidents

1. Introduction

Agriculture consistently ranks as one of the highest risk industry sectors in North America as well as in the European countries. Compared with other industries, agriculture (including forestry, hunting and fishing) is the most dangerous branch in Sweden, Norway and Denmark. About 19% (392) of all fatal occupational accidents in Sweden occurred in this sector during the time period 2003-2008 giving a fatality rate of 14 deaths per 100 000 workers and year compared to 1.5 for all branches combined [21].

Besides the suffering for the individual, the fatal and non-fatal accidents in agriculture have been estimated to cost society between 300 and 460 million \$US per year [29].

Farm operators are also involved in traffic accidents with tractors and other slow-moving vehicles (SMVs). These accidents often lead to injuries among farmers, family members, farm workers, and other road users.

The objective of this study is to reach a better understanding of accidents on Swedish roads involving tractors and to suggest ways of preventing them.

2. Materials and Methods

Official Swedish statistics on traffic injuries do not present specific information about farm vehicles and other SMVs. These are only included in the statistical category of "other vehicles". Together with Statistics Sweden we sorted out information on police-reported accidents involving SMVs from 1992 to 2005 including such vehicles as tractors, harvesters, other self-propelled farm equipment as well as horses and horse-drawn vehicles. The data material included information on the type of accident, severity of injury, type of road user, vehicle data, road conditions, and type of road, weather conditions, and many other aspects of the accidents. Only fatal accidents and accidents that led to physical injuries were selected.

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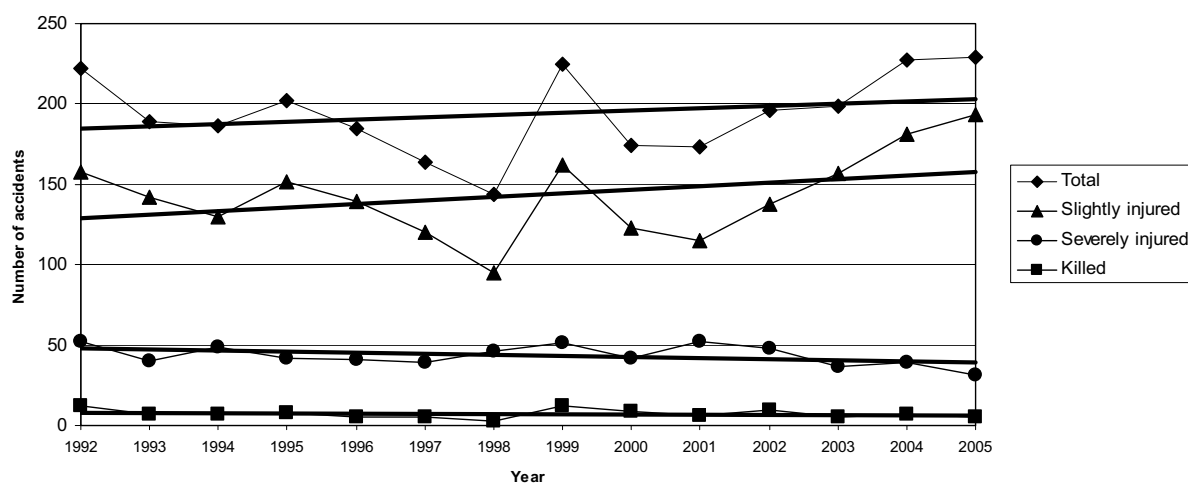


Fig. 1. Number of persons killed and injured in road traffic accidents involving tractor vehicles, reported by the police, according to severity of injury and year, 1992-2005.

The data for the years 1992 to 1996 are described in detail in the study by Pinzke and Lundqvist [23].

3. Results

Totally, 2542 accidents occurred with slow-moving vehicles that led to death or physical injuries during the time period 1992-2005. About 70% (1793) of these accidents involved tractors.

During each year of this period, tractors were involved in 128 traffic accidents on average on Swedish roads and an average of 7 people were killed, 44 sustained serious injuries, and 143 sustained slight injuries. Figure 1 shows a trend of an annual increase in the number of injured persons in the tractor accidents.

The tractor category contains vehicles of other types of bodywork besides tractors, e.g. rebuilt cars and pedestrian-controlled tractors. 324 tractors belonged to these other types of bodywork and for 471 tractors there was no information on the bodywork. The following presents the results of 990 accidents involving vehicles with bodywork tractors and where data on the tractor drivers' ages were available. In these accidents, 2447 drivers and

passengers were involved; of these 61 were killed, 352 severely injured and 1110 slightly injured.

The mean age of the tractor drivers involved was 45 years; most were aged 25 - 55 years. However, most of the tractor drivers who were killed or injured belonged to the younger and older age groups (Table 1). This also applies to drivers of other vehicles involved (Table 2). It is the drivers of the other vehicles, who more often were injured in tractor accidents. 33% of the tractor drivers were injured compared to 80% of the drivers of the other vehicles involved.

Passenger cars were most often involved in the tractor accidents (64%). Here the older tractor drivers were more often involved (69%). About 10% were single tractor accidents where the drivers in the age group 12-16 years were overrepresented (29%), (Table 3).

The most common tractor accidents occurred when turning at an intersection (30%), especially for the older drivers (35%). The young tractor drivers were more often involved in single crashes and oncoming collisions than the average (Table 4).

Overall, the greater number of accidents occurred during September (14%), October (12%), June (10%) and August (10%) and slightly more often on Mondays (17%) and Fridays (17%).

Table 1

Injuries among the 990 tractor drivers in tractor accidents during the time period 1992-2005 according to age of the drivers. Number and per cent (%)

Age group (years)	Killed	Severely injured	Slightly injured	Uninjured	Missing data	Total aged
12-16	1 (2.4)	7 (16.7)	9 (21.4)	25 (59.5)	0 (0)	42 (100)
17-24	2 (1.3)	13 (8.3)	45 (28.7)	96 (61.1)	1 (0.6)	157 (100)
25-55	7 (1.4)	28 (5.7)	100 (20.2)	350 (70.9)	9 (1.8)	494 (100)
56-64	3 (2.4)	9 (7.3)	32 (25.8)	78 (62.9)	2 (1.6)	124 (100)
65-91	6 (3.5)	12 (6.9)	51 (29.5)	99 (57.2)	5 (2.9)	173 (100)
Total	19 (1.9)	69 (7.0)	237 (23.9)	648 (65.5)	17 (1.7)	990 (100)

Table 2

Injuries among the 944* drivers of other vehicles involved in tractor accidents during the time period 1992-2005 according to age of the drivers. Number and per cent (%)

Age group (years)	Killed	Severely injured	Slightly injured	Uninjured	Missing data	Total aged
7-16	1 (4.2)	14 (58.3)	8 (33.3)	1 (4.2)	0 (0)	24 (100)
17-24	11 (6.6)	29 (17.4)	100 (59.9)	27 (16.2)	0 (0)	167 (100)
25-55	12 (2.4)	96 (19.0)	277 (55.0)	116 (23.0)	3 (0.6)	504 (100)
56-64	5 (5.8)	12 (14.0)	56 (65.1)	13 (15.1)	0 (0)	86 (100)
65-90	4 (3.0)	34 (25.4)	72 (53.7)	23 (17.2)	1 (0.7)	134 (100)
Total	33 (3.6)	185 (20.2)	513 (56.1)	180 (19.7)	4 (0.4)	915 (100)

* No data for 29 of the drivers

Table 3

Traffic elements involved in 990 tractor accidents during the time period 1992-2005 according to age of the tractor drivers. Number and per cent (%)

Age group (years)	Single	Passenger car	Lorry	Bus	Motorcycle	Moped	Bicycle	Pedestrian	Other	Unknown	Total aged
12-16	12 (28.6)	22 (52.4)	1 (2.4)	0 (.0)	1 (2.4)	0 (.0)	2 (4.8)	0 (.0)	4 (9.5)	0 (.0)	42 (100)
17-24	23 (14.6)	87 (55.4)	13 (8.3)	1 (.6)	10 (6.4)	3 (1.9)	2 (1.3)	4 (2.5)	13 (8.2)	0 (.0)	157 (100)
25-55	48 (9.7)	317 (64.2)	33 (6.7)	4 (.8)	37 (7.5)	18 (3.6)	11 (2.2)	9 (1.8)	16 (3.2)	1 (.2)	494 (100)
56-64	8 (6.5)	85 (68.5)	12 (9.7)	1 (.8)	5 (4.0)	2 (1.6)	5 (4.0)	3 (2.4)	3 (2.4)	0 (.0)	124 (100)
65-91	12 (6.9)	119 (68.8)	11 (6.4)	3 (1.7)	11 (6.4)	3 (1.7)	3 (1.7)	1 (.6)	8 (4.1)	2 (1.2)	173 (100)
Total	103 (10.4)	630 (63.6)	70 (7.1)	9 (.9)	64 (6.5)	26 (2.6)	23 (2.3)	17 (1.7)	45 (4.5)	3 (.3)	990 (100)

Table 4

Type of 815 tractor accidents during the time period 1992-2002 according to age of the tractor drivers. Number and per cent (%)

Age group (years)	Single	Passing and lane change	Rear end collision	Oncoming vehicle	Turning at intersection	Crossroad	Other	Unknown	Total aged
12-16	11 (31.4)	1 (2.9)	1 (2.9)	8 (22.9)	9 (25.7)	4 (11.4)	0 (0.0)	1 (2.9)	35 (100.0)
17-24	29 (21.2)	8 (5.8)	11 (8.0)	17 (12.4)	39 (28.5)	23 (16.8)	0 (0.0)	10 (7.3)	137 (100.0)
25-55	46 (11.3)	20 (4.9)	77 (18.9)	67 (16.5)	114 (28.0)	59 (14.5)	2 (0.5)	22 (5.4)	407 (100.0)
56-64	8 (8.2)	6 (6.2)	14 (14.4)	12 (12.4)	33 (34.0)	18 (18.6)	0 (0.0)	6 (6.2)	97 (100.0)
65-91	13 (9.4)	11 (7.9)	20 (14.4)	8 (5.8)	49 (35.3)	31 (22.3)	3 (2.2)	4 (2.9)	139 (100.0)
Total	107 (13.1)	46 (5.6)	123 (15.1)	112 (13.7)	244 (29.9)	135 (16.6)	5 (0.6)	43 (5.3)	815 (100.0)

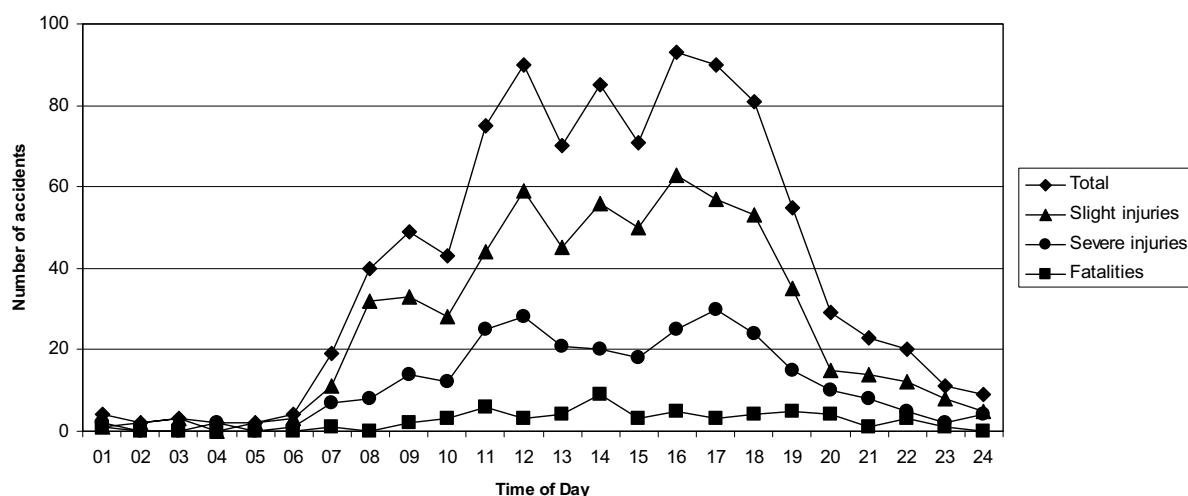


Fig. 2. Number of road traffic accidents with tractor vehicles reported by the police, according to severity of personal injury, and hour of the day, 1992-2005

Most tractor accidents involving deaths or injuries occurred in the daytime with small peaks between 3 and 5 p.m. and between 11 a.m. and 1 p.m. (Figure 2). About 17% of the young tractor drivers were involved in accidents that occurred between the hours of 11 a.m. and 1 p.m. compared to 9% on average of total.

Overall, tractor accidents occurred most often in daylight (77%), especially for the oldest tractor drivers (90%), in mainly fair weather conditions (87%), and on roads with speed limits of 70 km/h (39%) and 90 km/h (40%). In 66% of the cases, the roads were dry, 21% wet or damp, and 11% had icy or snowy roads.

Most accidents occurred outside the urban area (80%).

4. Discussion

Tractors and machinery have previously been shown to be a major cause of accidents in both the agricultural environment and traffic [18,24].

In Sweden, about three quarters of all fatal traffic accidents occur outside built-up areas [27]. In the present study we found that about 80% of both fatal and non-fatal tractor accidents occurred outside the urban area. This is in line with statistics from e.g. Germany and the United States [2,4]. American researchers present three reasons for the increasing fatal tractor/motor vehicle collisions in the United

States: 1) more people move to the countryside and commute to nearby cities, 2) improved rural roads permit high-speed driving, and 3) many farmers own or lease land that is not directly adjacent to their main farm land, so that tractor operators must spend more time on the roads [3]. One can assume that these statements also apply to Swedish conditions.

In 2008 there were 6 604 346 vehicles in use in Sweden: 4 802 668 cars (passenger cars, lorries and busses) and 322 065 tractors. About half of the tractor park was used in the agriculture and forestry sector [26].

During the same year, the total number of traffic accidents with fatal and non-fatal injuries reported by the police was 18 462 (excluding accidents resulting in deaths caused by illness) in which 397 persons were killed and 26 248 severely or slightly injured [28,32]. The traffic deaths in Sweden per 100 000 inhabitants and per billion vehicle-kilometres were 4.32 and 7.6, respectively [11]. This means that Sweden had about half the number of traffic fatalities per capita of the EU 27 average (7.8) [32]. Internationally, Sweden belongs to the group of countries with the lowest risks together with Iceland, the Netherlands, the United Kingdom, and Japan, which all had rates below 5.0 per 100 000 inhabitants, and together with Iceland, the Netherlands, Switzerland, Ireland and the United Kingdom with risk of less than 6 deaths per billion vehicle-kilometres. Countries with high risk per 100 000 inhabitants were the United States (12.25),

Greece (13.84), Poland (14.26) and Malaysia (23.5) [11].

The average of 7.2 persons killed and 187 injured in road accidents involving all sorts of tractor vehicles each year, as found in this study, corresponds to about 1.3% of all deaths and 0.8% of all injured in traffic accidents in Sweden during the same time period 1992-2005. The average rate of fatality for the time period estimated per 100 000 tractors of all kinds was 2.2 compared to 13.4 per 100 000 cars. The death rate per number of tractors may seem low, but will double if you only count the number of agricultural and forestry tractors, which is reasonable to do because 80% of accidents found in this study occurred in rural areas where these tractors are. If one also takes into account that only a small number of agricultural and forestry tractors are on public roads compared with the number of cars, lorries, etc., then the risk is many times greater.

It is also important to point out that the figures for both tractor vehicle and car accidents only represent accidents that resulted in a police report. It has been known for a long time that many traffic accidents are not known to the police, but are dealt with by the health service [13]. It is believed that the official statistics for road traffic accidents presented, in a comparison with hospital data, might represent only as little as 30 per cent of the lighter injuries and approximately 60 per cent of the more serious injuries [1]. Thus, the accident figures shown in this study should be even higher in reality.

Several studies have shown that it is the older farmers who are particularly affected by accidents [6,20,24,25]. In Sweden, 56% of those who died from work-related injuries in the agriculture sector were 55 years old or more [31]. The risk of injury increases with physiological age changes [17] and injuries suffered by the elderly are more serious [19].

The results of this study show that it was the oldest and youngest drivers who were slightly overrepresented in the fatal tractor crashes.

It was more common for both older and younger drivers that their tractor accidents occurred in daylight and in clear weather on a dry road surface, i.e. in favourable traffic conditions, than for other age groups. This may indicate that for older and younger drivers there are also factors other than the external circumstances that can contribute to traffic accidents.

Generally, most accidents occurred during the harvesting season, when more farm vehicles travel on public roads. This was also found in five-year data (1995-1999) on farm vehicle public road crashes in North Carolina [10] as well as on 797 crashes on

Iowa's public roads during the period 2002-2005 [33]. The elderly in the present study were particularly involved in the accidents in August and September. A possible explanation for these accidents is the increased stress and fatigue caused by long working hours during harvest in these months in combination with the older generation's generally decreased resistance to stress and fatigue.

Monday was the most unfortunate day of the week for both the younger and the older age groups. Possibly after the weekend break there can be a feeling of uncertainty in the traffic situation that increases the propensity for accidents at the beginning of the week for both the youngest and oldest age groups.

The highest number of tractor vehicle public road crashes was, in this study, reported to be between 3 and 5 p.m. It was also mainly in the afternoon that tractor accidents occurred for the younger and older tractor drivers. The peak for farm vehicle crashes in both North Carolina and Iowa was found to be in late afternoon when commuter traffic is coming home from work and farm operators are likely to be returning from their fields [10,33].

In the present study, the most common traffic situations at the time of the accidents were turning at intersections, especially left-turn collisions, followed by crossroad and rear-end collisions. A similar pattern of accident situations is reported in other studies [2,7,9,12,14,33]. The left-turn collision occurs when the tractor operator is attempting to turn left as a motorist is passing. Rear-end collisions occur because the motorist does not see the tractor in time [33]. According to a Swedish study of driving school teachers' opinions about farmers on the road, decisive factors for the occurrence of accidents in these situations include lack of visibility of the tractors and the difference in speed between the vehicles involved [15,16]. Tractors move mostly at low speeds at less than 30 km/h, while motorists can travel at speeds of may be 90 km/h. This relationship is the most common contributory factor in accidents where the motorist fails to reduce speed [5].

In the older age groups the accidents particularly happened when the tractor turned off on to a road, with cars travelling in the same direction and on to roads with speed limits of 90 km/h. With increasing age comes biological and functional aging, which generally means, for example, a lower degree of alertness, impaired vision and range estimation. Possibly, this may increase the risk of accidents among older tractor drivers in traffic situations

involving turning out on to or off a road with other vehicles travelling at greater speeds.

The results found in this study that it is the drivers in the other vehicles, which more often become injured in tractor accidents is in line what was found in an American study. Peek-Asa et al. found that non-farm vehicle drivers were 5.2 times more likely to be injured than farm vehicle/equipment drivers [22].

The size of the tractor vehicle park in Sweden has basically remained at a constant level for ten years. Eight out of ten tractors are 15 years old or more. Just less than 7 per cent of the tractors are more than 4 years old. The average age of tractors in use in 2008 was 29.7 years [26]. In light of the many old tractors in use it is very important for the farmer to keep the farm vehicles in good shape for safety reasons. Gkritza et al. found that crashes involving older farm vehicles were more likely to result in major injury or fatality. Older farm vehicles could lack safety features such as safety belts, rear-view mirrors and rollover protective structure, which are installed in newer farm vehicles and can prevent severe injury outcomes [8].

We are now increasing the data collected with the years 2006-2010 in order to study the changes in the number of accidents. Special attention will be given to the younger drivers and to single vehicle accidents. Based on the results we aim to develop suggestions for reducing road accidents, including measures for making farm vehicles more visible, improvement of the training provided at driving schools, and information campaigns directed at drivers of farm vehicles and other road users. Our injury prevention work is consistent with the "Vision Zero" program approved by the Swedish Parliament in 1997, which specifies zero fatalities or serious injuries in Swedish road traffic.

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