Assessing Farm Tractor Incidents and Awareness Levels of Operators for Tractor Safety Issues in the Hatay Province of Turkey

S. Görücü Keskin, M. Keskin, Y. Soysal

ABSTRACT. *Studies and statistical data on safety issues related to farm tractors and machinery are very limited in developing countries, including Turkey. This study was carried out to investigate tractor-related incidents in the Hatay province, located in the mid-south of Turkey. A questionnaire was conducted with 107 tractor operators using face-to-face interviews. Data were evaluated according to the incident type, machinery involved, and mechanism of injury or fatality. A total of 101 incidents were reported by 77 of the 107 respondents. Most of the incidents were due to tractor rollovers (65.4%), 14.8% of the incidents were due to entanglement of body parts in moving machinery, and 12.9% involved crashing into other vehicles or obstacles. The leading cause of the incidents was personal mistakes (60.4%). Fatalities resulted from 25.7% of the incidents, while 45.5% of the incidents caused non-fatal injuries. Only 5.6% of the tractors had a ROPS-enclosed cab. The percentage of ROPS-equipped tractors was 19.6%, while 41.3% of the tractors had a shade cover and 33.6% had no protective structure. Only one of the respondents used a seatbelt, although 44.9% of them stated that seatbelts should be used. It was also found that only 13.5% of the operators had training in work safety, while 95.1% stated that incidents might be reduced if people were trained. Development of appropriate policies and training programs are needed for safer operation of agricultural machinery to reduce injuries and fatalities due to farm accidents.*

Keywords. *Accident, Fatality, Injury, Safety, Tractor.*

Work safety is the most crucial subject for workers dealing with machinery. Studies show that most harmful accidents happen in three sectors: agriculture, construction, and transportation (NIOSH, 2002). Agriculture is usually considered among the three most hazardous sectors depending on the country, time of the examination, and severity of the incidents (Murphy, 1986; Rissanen and Taattola, 2003; Suutarinen, 2004). According to Lundqvist (1996), 51% of agricultural workers, 46% of construction workers, and 37.5% of transportation workers feel themselves at risk in their work environment. Franklin et al. (2001) stated that the fatality rate for the agricultural industry was four times higher than the rate for other industries. Myers et al. (1998) reported that half of the incidents in agriculture were related to ma-

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chinery, and that half of these incidents were related to tractors. They also reported that the major source of injuries and fatalities was tractor rollovers and runovers.

Studies have been carried out on tractor and farm injury incidents in different countries. Franklin et al. (2001) studied farm-related fatalities in Australia from 1989 to 1992. They stated that the fatality rate for the agricultural industry was four times higher than the rate for other industries, and they reported that 95% of the deaths in agricultural incidents involved male workers. Ambe et al. (1994) studied the perceptions of tractor operators in Pennsylvania regarding on farm safety and stated that the operators did not pay enough attention to tractor safety issues. Whitman and Field (1995) conducted a survey study on the perceptions of senior farmers (n = 295) regarding farm tractors and machinery safety issues. The farmers stated that tractor hazards were moderately risky, although 83% of the respondents agreed that tractor-related injuries were severe. Sprince et al. (2003) assessed potential risk factors for agricultural injuries and found close relationships between farm-related injury and several factors, including weekly working hours, the presence of large livestock, education beyond high school, regular medication use, wearing a hearing aid, and younger age. McCurdy et al. (2004) studied nonfatal farm incidents and stated that on average 8.2 out of 100 farmers had farm-related injuries every year. The most common causes of the injuries were overexertion (24.2%), machinery factors (14.3%), falling (13%), and animals (12.4%). Mariger et al. (2009) studied the causes of injuries in agricultural operations and found that the overall injury rate was 5.6 injuries per 100,000 hours, and farm workers in the 45-64 age group sustained the most injuries. The researchers also determined that older and more experienced farmers reported fewer injuries because of limited exposure to hazards and greater work experience.

Rollover protective structures (ROPS) are used to create safe working conditions for tractor operators and are defined as "a cab or frame that provides a safe environment for the tractor operator in the event of a rollover" (NASD, 1996). In case of an incident, if there is a ROPS and the seatbelt is fastened, the incident is expected to be non-fatal for the tractor operator. Lehtola et al. (1994) reported that in the five-year period 1988-1992, there were no reported deaths in overturns involving tractors equipped with a ROPS in Iowa. Whitman and Field (1995) indicated that ROPS were undervalued by farmers; while a majority of farmers (88%) accepted ROPS' effectiveness, only 42% had ROPS on their primary tractors. Springfeldt et al. (1998) stated that the use of ROPS increased from 6% to 93% as the fatalities decreased in their 30-year study period. Loringer and Myers (2008) reported that only 51% of the tractors used in the U.S. had ROPS.

Seatbelt use on tractors has also been studied by many researchers. Myers et al. (2006) studied tractor rollovers and the presence of seatbelts for over 6,000 tractor operators and stated that if the seatbelt was fastened on ROPS-equipped tractors, then only minor injuries were observed to the tractor operator in an overturn. Myers and Hendricks (2010) reported that tractor overturn fatality rates declined by 28.5% between 1992 and 2007 in the U.S. and tied this reduction partially to the increased prevalence of ROPS on farm tractors. Hard and Myers (2011) found that the states with the highest percentage of ROPS on tractors generally had lower fatality rates for tractor overturns, whereas states with lower ROPS usage had higher fatality rates. Harris et al. (2011) reported that agricultural tractor overturns kill more than 100 workers each year in the U.S. and that ROPS can prevent most of these deaths.

Many studies have been conducted on safety issues with agricultural machinery in developed countries. Researchers in developed countries use available statistical data or

collect data through questionnaires. However, most developing countries do not have a statistical database for agriculture-related injuries. Javadi and Rostami (2007) drew attention to the lack of a validated database for agricultural incidents in Iran, and they conducted a study to assess the most common causes of agricultural injuries. They classified the causes of the incidents as 53% personal mistakes and 40% both personal and mechanical causes. Tractors and rotating parts were the main causes in machinery-related incidents. Patel et al. (2010) conducted a survey in India during a five-year period (1996-2000) and reported that out of 106 injuries, 9% were fatal and 91% were non-fatal. Fifty-seven injuries were related to farm machinery, 43 were due to hand tools, and six were from other sources. Males constituted 79% of the victims, while 21% were female.

As in most developing countries, work safety in agriculture has not been adequately studied in Turkey, and very limited data are available on injury incidents. Gölbaşı (2004) studied 880 tractor injury incidents that occurred between 1990 and 2001 and reported that 83% of them were caused by personal factors, 10% were environment-related, and 7% were machinery-related. The most common incident type was tractor rollovers (60%). Oz (2005) conducted a questionnaire study with 250 farmers in the Aegean region of Turkey and reported that 27% of the farmers (n = 66) had a total of 72 accidents. The most common incident was rollovers (27%), and 70% of the incidents involved farmers between 20 and 40 years old. Akbolat et al. (2007) studied tractor and agricultural machinery incidents from 1995 to 2003 in the Isparta province of Turkey. They classified the incidents as 57.6% crashes, 35.8% rollovers, 4.4% running off the road, 1.1% collisions with pedestrians, and 1.1% falling from the vehicle. A training project named SAFER that targeted agricultural machinery manufacturers, professional farmers, farm family members, and seasonal farm workers was initiated as a multinational project in the Samsun province of Turkey. In this project, training materials including audiovisual materials and leaflets were produced to train farm machinery operators, farmers, and workers (SAFER, 2011). Dogan et al. (2010) reported that 86 out of 3,940 death cases (2.2%) were caused by tractor accidents in which a death examination and/or autopsy was performed in the Konya province of Turkey in the years 2000-2007. The ages of the victims varied between 3 and 80 years, with a mean age of 31.7 ±22.3 years. While 79.1% of the cases involved males, 20.9% of the cases involved females. Tractor overturns were the cause of 37.2% of the deaths.

Detailed data are not available on injuries related to agricultural machinery in Turkey. The studies conducted by individual researchers concentrated on some parts of Turkey, but we found very limited statistical data collected by government agencies on farm tractor incidents. These limited data included the number of traffic accidents causing material loss, injury, and death according to vehicle type, including farm tractors on roads. In 2007, 3,544 tractor incidents occurred on roads in inhabited and uninhabited areas in Turkey; 63 of these incidents resulted in death (27 were tractor operators, while 36 were passengers in another vehicle or extra riders on tractors); 1,029 incidents resulted in injury (377 were tractor drivers, and 652 were in another vehicle or extra riders on tractors); and 2,452 incidents resulted in material loss only (TurkStat, 2007, pp. 66-70). The total number of tractors in Turkey was 1,056,128 in 2007 (TurkStat, 2011b). No official statistical data were found on incidents in the farm work environment. Since 2000, the use of ROPS has been required by law in Turkey on agricultural and forest tractors, including tractors manufactured before 2000 (Engurulu et al., 2001). Despite this, ROPS usage is very limited in Turkey. The reasons behind this could depend on two factors: the tractor operators' lack of knowledge regarding the importance of ROPS, and the lack of strict

regulations on the use of ROPS by government agencies. Most recently produced tractors have ROPS; however, ROPS usage is not strictly enforced.

No studies have been reported on incidents involving farm tractors and machinery in the Hatay province, and no statistical data are available on injury incidents that have occurred during agricultural operations on farms. It is crucial to study the reasons for injury incidents based on the results obtained. The objectives of this study were:

- To acquire numerical data and determine the causes of tractor injury incidents in the Hatay province.
- To determine the current status of the training and knowledge of tractor operators regarding work safety issues.
- To compare these results with the results of studies in other countries.

Materials and Method

This study was conducted in the Hatay province of Turkey and was based on an interview questionnaire. Hatay is one of the 81 provinces of Turkey and is located in the mid-south of Turkey. It is bordered by the Adana, Osmaniye, and Gaziantep provinces in the north, Syria in the east and south, and the Mediterranean Sea in the west. The Hatay province has a total land area of 5,867 km^2 (TurkStat, 2009), and the agricultural land area is 273,337 ha, of which 158,448 ha are cereal and field crops, 36,610 ha are vegetable gardens, and 78,279 ha are fruit and herbs gardens (TurkStat, 2011a). In 2009, the number of farm tractors was 1,073,538 in Turkey and 15,970 in Hatay (TurkStat, 2011b). The most important agricultural production includes cereals, cotton, corn, sunflower, olives, citrus, vegetables, fruits, and medicinal and aromatic plants. The Amanos Mountains, with highest peaks of about 1,000 m, stretch from southwest to northeast, dividing the province into two regions. The land of the Hatay province has different climatic conditions and land characteristics. For example, some areas of the province close to the Amanos Mountains have sloping land, making tractor operations risky, while areas in the Amik Plain, in the center of the province, are flat. The Amik Plain is an important agricultural region of Turkey. Because of the variable land characteristics of the province, this study can represent different parts of Turkey in terms of agricultural machinery accidents.

The survey questionnaire consisted of five pages and asked for personal information, past tractor-related accidents and injuries, and perceptions of safety issues. The survey included questions in the following eight categories:

- Personal information
- Health condition and insurance
- Consumption of addictive substances (alcohol and cigarettes)
- Land property data
- Machinery, equipment, and crop information
- Experience and work safety training history
- Accident and injury history
- Work safety knowledge and awareness.

The questionnaire was conducted with 107 tractor operators using face-to-face interviews in different parts of the Hatay province in 2010 and 2011. The survey study was conducted by the authors with randomly selected tractor operators. The selection of subjects was based on the topography of the land. About 30% of the province has sloping

land, and the percentage of the tractor operators surveyed from the sloping regions was 26%. Data analysis was carried out using SPSS software (ver. 16.0).

Results and Discussion

Characteristics of the Tractor Operators

Most of the tractor operators (73 out of 107) worked on their own fields, five tractor operators worked on both their farms and other farms, while 29 operators worked as hired operators. The average age of the respondents was 43.7 (table 1). Forty-nine out of 107 operators were primary school graduates. The size of the farms ranged from 0.5 to 600 ha, with an average of 15.3 ha (table 1).

The percentage of the tractor operators who did not have any health insurance was 13.1%. Body mass index (BMI) calculations showed that 33 of the 107 tractor operators were normal, 49 were overweight, and 25 were obese. About 66.4% (n = 71) of the respondents stated that they had no health problems, while 33.6% (n = 36) had various health problems such as back pain, visual problems, and hearing problems. The percentages of the operators who used tobacco and alcohol were 50.5% (n = 54) and 7.5% (n = 8), respectively.

The age, tractor use experience, and formal education of the respondents were also obtained during the interviews. The numbers of tractor operators in each age group were not equal. Most of the operators (47.7%) were in the 40-49 age group, with an average age of 44.4 (table 2). The mean tractor experience of the operators was 22.6 years, while the mean school education was 7.3 years for all 107 operators.

Condition of the Tractors

The tractor operators were asked about their tractors' make, model, power, and the presence of a ROPS, ROPS-enclosed cab, or shade cover. In this study, we used the term ROPS for U-shaped protective structures apart from a ROPS-enclosed cab. Data were

Table 1. Socio-economic characteristics of tractor operators.

Average farm size (ha)		Mean = 15.3, Min. = 0.5, Max. = 600
Age		Mean = 43.7, Min. = 20, Max. = 75
Education level:	Illiterate	1
	Literate	1
	Primary school	49
	Secondary school	27
	High school	18
	University	11

Table 2. Characteristics of tractor operators according to age groups.

Age Group (years)	Count	Mean Age	Mean Tractor Experience (years)	Mean School Education (years)
20-29	11 (10.3%)	23.4	8.6	10.0
30-39	16 (14.9%)	35.3	16.6	8.0
40-49	51 (47.7%)	44.4	23.9	7.1
50-59	22 (20.6%)	51.8	25.2	6.6
60 or older	7 (6.5%)	64.0	40.3	5.6
Total	107 (100.0%)	43.7	22.6	7.3

collected on 143 tractors. This number is higher than the number of operators questioned (n = 107) because some of the operators had more than one tractor. The average year of manufacture was 1991 (standard deviation = 11.4, median = 1990), and the oldest reported tractor was from 1964 (table 3). The most common make was Massey Ferguson (29%). The percentages of Ford, Fiat, New Holland, and John Deere were 23%, 20%, 10%, and 8%, respectively. The rest of the tractors were other makes. The average tractor power was 49.1 kW (66.8 hp) (standard deviation = 10.1 kW, median = 48.6).

Analysis of the Incidents

The tractor operators were asked if they had experienced, witnessed, or heard of any tractor-related incidents. They were not limited to a specific time period. A total of 101 incidents were reported by the respondents. Some of the operators did not report any incidents. The percentage of non-fatal injury incidents that the tractor operators experienced themselves was 23.4% (n = 25). The respondents also reported a total of 76 fatal and non-fatal injury incidents involving friends or relatives. The gender, age, and experience of the victim, reason for the incident, fatality, level of injury, body part injured, and the time period not worked after the incident were among the questions asked. The names of the victims were also asked in the questionnaire, and duplications were eliminated by removing the same name if it was repeated more than once.

Most of the incidents (n = 66; 65.4%) were due to tractor rollovers (table 4). The percentage of the incidents due to entanglement of body parts in moving machinery was 14.8%, while 12.9% of the incidents involved crashing into other vehicles or obstacles. The other types of incidents included falls from tractors, skidding, etc. Similar to our findings, Gölbaşı (2004) reported that the most common accident type was rollover (60%) in the Ankara province of Turkey. Oz (2005) also reported that rollovers were the most common type of accident (27%); however, the rate he reported was much lower than our finding and the rate reported by Gölbaşı (2004). In contrast with these findings, Akbolat et al. (2007) stated that the most common accident type was crashes (57.6%), while rollovers (35.8%) were the second most common accident type in the Isparta province of Turkey.

It was observed that 26 of the 101 reported incidents were fatal, while 46 resulted in serious injuries, and 29 caused slight or no injury (table 5). Eighteen out of 26 (69.2%)

Table 3. Number of tractors according to year of manufacture.

Year of Manufacture	Number of Tractors
1964-1970	6
1971-1980	23
1981-1990	44
1991-2000	30
2001-2010	40
Total	143

Table 4. Type of tractor incidents observed in the study.

	Frequency	Percent (%)
Rollover	66	65.4
Entangle	15	14.8
Crashing	13	12.9
Runover	1	1.0
Other	6	5.9
Total	101	100.0

Table 5. Number of injuries and fatalities according to type of accident.

	Rollover	Entangle	Crashed	Runover	Other	Total
Injury	30	7	6	-	3	46 (45.5%)
Fatal	18	2	4	1	1	26 (25.7%)
No injury	18	6	3	-	2	29 (28.7%)
Total	66	15	13	1	6	101 (100.0%)

fatalities were caused by tractor rollovers. These data are in line with the data reported by Twari et al. (2002), who stated that 66.7% of tractor-related fatal incidents were due to overturning. Lehtola et al. (1994) stated that 55% of fatalities were associated with tractor rollovers. Similarly, Langley et al. (1997) reported that most of the fatalities (55%) in their study were caused by tractor overturns. In contrast, Dogan et al. (2010) reported that 32 out of 86 fatalities (37.2%) were due to tractor overturns.

Eighteen out of 66 (27.3%) rollover accidents were fatal, while 30 out of 66 (45.4%) resulted in injury (table 5). Rissanen and Taattola (2003) reported a similar fatality rate for rollover incidents (26.1%). We found a fatality rate of 31% (4 out of 13) for crash accidents. This value is much higher than the 14% reported by Lehtola et al. (1994).

Males constituted 95% of the victims killed or injured. Dogan et al. (2010) reported that 68 out of 86 fatalities (79.1%) involved males, while 18 out of the 86 fatalities (20.9%) involved females. Similarly, Patel et al. (2010) reported that males constituted 79% of the victims, while 21% of the victims were female. In this study, female workers were mainly involved in entanglement incidents when their hair, clothes, etc., were captured by the rotating parts of agricultural machinery. In rural parts of Turkey, women traditionally wear long skirts, salvar (baggy trousers), and headscarves, which make them potentially vulnerable to entanglement incidents.

There were 46 serious injuries in 101 incidents; however, the injury types of only 42 injuries were obtained from the respondents. Twenty-eight out of 42 (66.7%) reported injuries to arms and legs (table 6). This means that the most injured body parts were arms and legs. Five of the victims had lost body parts (legs or arms) because of entanglement, and they became permanently disabled and could not work after the incident. Thirteen injured people could not return to work for more than a month after the incident.

The operators were asked to tell how the incidents happened. We then classified the incidents by cause based on the responses of the operators. The incident causes were classified into three groups: personal, machinery, and environmental. Some of the incidents occurred because of more than one factor. The personal factors were carelessness, inappropriate clothing, speeding, sudden speeding/braking/passing, overloading, sleeping, standing on the drawbar, standing close to rotating parts of the machinery, and sleeping under a trailer. The machinery-related factors were lack of maintenance, mechanical breakdowns, and lack of signs on the vehicle while moving on the highway. The environmental factors were slippery surfaces, ditches, holes, slopes, curves, stones, and stumps. Most of the incidents were due to personal factors (61 out of 101; 60.4%) (ta-

Table 6. Type of serious injury according to type of accident.

	Rollover	Entangle	Crashed	Other	Total
Head	1	3	2	1	7
Body	4	-	2	-	6
Arms and legs	13	11	2	2	28
Psychological	1	-	-	-	1
Total	19	14	6	3	42

ble 7). Fifteen out of 26 (57.7%) fatal incidents and 33 out of 46 (71.7%) injury incidents were caused by personal factors. These data are in line with data reported by Javadi and Rostami (2007), who reported that most (53%) tractor incidents in Iran were due to personal factors. Gölbaşı (2004) reported a similar finding, stating that 83% of 880 tractor incidents in 1990-2001 in Turkey were caused by personal factors. McCurdy et al. (2004) reported that the most common causes of injuries were overexertion (24.2%), machinery factors (14.3%), fallings (13%), and animals (12.4%).

The data on the incidents were also organized based on the season and time of day (table 8). Most of the incidents occurred in summer (44.6%). The percentage of the incidents that happened in spring was 28.7%, while 18.8% happened in fall. In Hatay, summer and spring are the busiest seasons, so the incident rate is higher in these seasons. Most of the incidents happened in the afternoon (28 out of 101; 27.7%) and evening (22 out of 101; 21.8%). The increased incident rate in the afternoon and evening could be explained by operator fatigue and lack of concentration.

Table 9 shows the work duration before the incident. Data on the working hours before the incident were available for only 62 of the 101 incidents. Most of the incidents (53.2%) were in the 0-5 hour group. However, 55.6% (10 out of 18) of the fatal incidents occurred in the 6-10 hour group (table 9). Fatigue is most likely to occur and concentration is lost after working more than five hours.

Incidents were also categorized according to the location of the incident: rural road, highway, field, or farmstead. Paved roads with more than two lanes were considered highways. Rural roads are usually not paved in the Hatay province. It was observed that 43.6% of the incidents occurred during field work, 28.7% occurred on highways, 24.8%

Table 7. Causes of accidents.

	Injury	Fatal	No Injury	Total
Machinery	1	-	2	3 (3.0%)
Personal	33	15	12	61 (60.4%)
Environmental	1	-	7	8 (7.9%)
Machinery + Personal	5	2	-	7 (6.9%)
Personal + Environmental	5	7	8	20 (19.8%)
Machinery + Personal + Environmental	1	2	-	3 (3.0%)
Total	46	26	29	101 (100.0%)

Table 8. Occurrence of incidents according to season and time.

Season	Morning (6:00-10:00)	Forenoon (10:00-11:00)	Noon (12:00-14:00)	Afternoon (14:00-17:00)	Evening (17:00-19:00)	Night (19:00-6:00)	No Data	Total
Summer	5	5	8	16	4	2	5	45 (44.6%)
Winter	1	1	-	1	2	-	-	5 (4.9%)
Spring	6	4	3	8	6	1	1	29 (28.7%)
Fall	-	3	2	3	9	2	-	19 (18.8%)
No data	-	-	1	-	1	-	1	3 (3.0%)
Total	12	13	14	28	22	5	7	101 (100%)

Table 9. Worked hours before the incident and the result.

Working Hours	Injury	Fatal	No injury	Total
0-5 hours	15	7	11	33 (53.2%)
6-10 hours	10	10	6	26 (41.9%)
>10 hours	1	1	1	3 (4.8%)
Total	26	18	18	62 (100%)

Table 10. Location of incidents according to accident type.

	Rollover	Entangle	Crash	Runover	Other	Total
Rural road	21	2	2	-	-	25 (24.8%)
Highway	20	-	6	-	3	29 (28.7%)
Field	25	13	2	1	3	44 (43.6%)
Farmstead	-	-	3	-	-	3 (3.0%)
Total	66	15	13	1	6	101 (100%)

Table 11. Age distribution of victims killed or injured in an incident.

Age Group (years)	Percent of Victims
Less than 20	18 (18.4%)
20-29	26 (26.5%)
30-39	23 (23.5%)
40-49	21 (21.4%)
50-59	5 (5.1%)
60 or older	5 (5.1%)
Total	98 (100.0%)

occurred on rural roads, and 3.0% occurred on the farmstead (table 10). The percentage of rollovers on highways was 30.3% (20 out of 66). Lehtola et al. (1994) reported that 37% of fatal overturns occurred on public roadways.

The data were also analyzed to determine whether the age of the operators had any influence on the number of injuries and fatalities. The ages for 98 out of 101 victims were available in the study. The youngest victim was 6 years old, while the oldest one was 65 years old. Most of the incidents (68.4%) occurred to younger victims (less than 40 years old) (table 11). Patel et al. (2010) found a similar result, reporting that the highest number of victims was in the 30-44 age group (36 out of 106). Dogan et al. (2010) reported that the ages of victims varied between 3 and 80 years old, with a mean age of 31.7.

Rollover Protection Structures (ROPS)

The tractor operators were asked about the presence of ROPS or ROPS-enclosed cabs on their tractors. We used the term ROPS for U-shaped protective structures apart from a ROPS-enclosed cab. The total number of tractors was 143. Only 5.6% of the tractors had a ROPS-enclosed cab (n = 8). The percentage of ROPS-equipped tractors was 19.6% (n = 28). The percentage of tractors that had either ROPS or a ROPS-enclosed cab was 25.2% (n = 36). Of the remaining tractors, 41.3% had a shade cover, while 33.6% had no ROPS-enclosed cab, ROPS, or shade cover. Oz (2005) conducted a questionnaire study of 250 farmers in the Aegean region of Turkey and reported that 52% of the tractors did not have ROPS-enclosed cabs or ROPS. He also reported that 54% of the operators removed the ROPS from their tractors due to various reasons. Most of the respondents were aware of the benefits of ROPS-enclosed cabs and ROPS; however, some respondents stated that a ROPS prevents working properly between tree rows. About 30% of the operators did not have any idea about a ROPS and its function. The percentage of the tractors with ROPS-enclosed cabs (5.6%) and ROPS (19.6%) is much lower than the results found in developed countries, as reported by Whitman and Field (1995) (42%), Springfeldt et al. (1998) (93%), and Loringer and Myers, (2008) (51%).

The use of a ROPS is crucial since it protects the operator from fatality in case of a rollover. ROPS have been required by law on agricultural and forest tractors in Turkey since 2000, and this law involves tractors manufactured before the year 2000 (Engurulu

Figure 1. Tractor with a shade cover.

et al., 2001). Despite this, ROPS usage is very limited in Turkey. More recently produced tractors have ROPS; however, ROPS usage is not strictly enforced. It is crucial to force the operators to use ROPS or ROPS-enclosed cabs.

The use of shade covers on tractors to protect the operator from sun or rain is common in Turkey (fig. 1). Some respondents mentioned that the shade cover created a protected area in case of an incident. However, most shade covers are designed solely to protect the operator from the weather and do not have enough strength to protect the operator in case of a rollover. This finding on the use of shade covers is important since shade covers may not protect tractor operators from injury. The strength of shade cover structures has not been studied before. It is important to determine the size and strength that a shade cover should have in order to protect the operator in case of an accident.

Seatbelt Usage

All but one of the respondents reported that they did not use the seatbelt while operating their tractors. As stated earlier, the percentage of tractors that had either ROPS or a ROPS-enclosed cab was 25.2% (n = 36); therefore, most of the operators whose tractors had ROPS or ROPS-enclosed cabs did not use seatbelts. When asked if the seatbelt should be used, 54.2% of the operators stated that it should not be used (table 12). When the answers were assessed according to age group, the percentage of "Yes" responses was highest in the youngest age group (81.8%). The older the age group, the greater percentage of "No" responses, meaning "the seatbelt should not be used in the tractor." Relationships between age groups and the answers to the question "Should the seatbelt be used?" were examined via Pearson chi-square tests, and it was found that the answers were significantly different among age groups ($p < 0.05$). The younger tractor drivers tended to give positive answers to the use of seatbelt in operating their tractors.

Because seatbelts should not be mounted on tractors without ROPS, the respondents who stated that the seatbelt should be used while operating the tractor were also asked in what conditions it should be used (table 13). Over one-quarter (29.2%) stated that the seatbelt should be used only while driving on the road, while 25.0% said it should be used while working if a ROPS or ROPS-enclosed cab is installed on the tractor. The percentage of the respondents who answered that the seatbelt should be used only while

Table 12. Responses of the tractor operators on using seatbelt on tractors.

Age Group	Should Seatbelt Be Used on Tractors?			
(years)	Count	Yes	No	Sometimes
20-29	11	9 (81.8%)	2 (18.2%)	-
30-39	16	8 (50.0%)	7 (43.8%)	1 (6.3%)
40-49	51	22 (43.1%)	29 (56.9%)	-
50-59	22	7 (31.8%)	15 (68.2%)	-
60 or older	7	2 (28.6%)	5 (71.4%)	-
Total	107	48 (44.9%)	58 (54.2%)	1 (0.9%)

Table 13. Answers to the question "In what conditions should the seatbelt be used?"

Responses	Number	
1. Only while working	8	(16.6%)
2. Only on the road	14	(29.2%)
3. Both while working and on the road	6	(12.5%)
4. If there is ROPS or ROPS-enclosed cab	3	(6.25%)
5. If there is no ROPS or ROPS-enclosed cab	0	(0%)
6. While working and if there is ROPS or ROPS-enclosed cab	1	(2.1%)
7. On the road and if there is ROPS or ROPS-enclosed cab	2	(4.2%)
8. While working or on the road and if there is ROPS or ROPS-enclosed cab	12	(25.0%)
9. While working or on the road and if there is no ROPS or ROPS-enclosed cab	2	(4.2%)
Total	48	(100.0%)

working was 16.6%. Some of the respondents stated that the seatbelt prevented working properly since the operator needs to move around in the seat to watch the operations.

Myers et al. (2006) studied tractor rollovers and the presence of seatbelts. They investigated overturns and found that if the seatbelt was fastened in ROPS-equipped tractors, then only minor injuries occurred to the tractor operator in the event of a rollover. A ROPS in combination with a fastened seatbelt during an overturn prevented serious injuries. Only one of the respondents in our study used a seatbelt, even though 44.9% of them stated that seatbelts should be used. This shows that tractor operators need to be trained about the use of seatbelts. It should also be noted that seatbelts should not be mounted on tractors without ROPS.

Use of Farm Tractors for Transportation

Farm tractors are designed for working conditions rather than for traveling on highways. They have low travel speed and high ground clearance, making them unsafe to drive on highways at high speeds. Nevertheless, it is common to see farm tractors traveling on highways in the Hatay province and other parts of Turkey (fig. 2).

Farmers who have low incomes and cannot afford another vehicle for transportation often use their farm tractors for this purpose. This creates a potential for tractor accidents on the roads. In 2007, 3,544 farm tractor accidents occurred on roads in inhabited and uninhabited areas in Turkey; 63 of these accidents resulted in death, 1,029 resulted in injury, and 2,452 resulted in material loss only (TurkStat, 2007, pp. 66-70). These numbers reflect only reported highway accidents; many rural accidents are not reported to the police or other agencies. Thus, the actual number of accidents is likely higher than these numbers suggest.

In our study, 50.5% of the respondents (54 out of 107) stated that they use their tractor for transportation on average for 17 km on highways and 8 km on rural roads. About 44.9% of the tractor operators did not use their tractor for transportation, while 4.7% of

Figure 2. Common use of farm tractors without ROPS on highway.

them used it sometimes. Even though half of the respondents used their tractor for transportation, most of them (80.4%) stated that it was not right to do so. Eleven percent of the respondents stated that it was right to use their tractor for transportation purposes, while 8.4% of the respondents stated that tractors could be used for transportation only when it was necessary. The answers to the question "Do you use the farm tractor for transportation?" was statistically analyzed according to the education level of the respondents, and no significant differences were found ($p > 0.05$). A similar analysis was carried out for the answers to the question "Is it right to use tractors for transportation?", and there was no difference among the respondents with different education levels ($p > 0.05$). In sum, we found no relationship between the education level of the respondents and their use of tractors for transportation.

Allowing Extra Riders on Farm Tractor

Agricultural tractors are not designed to carry extra riders. However, it is common to see farm tractors carrying people on highways in the Hatay province and other parts of Turkey (fig. 3). In our study, 43.9% of the respondents (47 out of 107) stated that they did not allow extra riders, but 53.3% of the respondents (57 out of 107) allowed extra riders on their tractors (table 14). In answer to the question "Is it right to allow extra riders on tractors?", 87.9% of the respondents answered that it is not right to allow extra riders on tractors. Chi-square analysis showed no significant difference among the age groups ($p > 0.05$) even for the younger age group, but the percentage of "Yes" responses for the younger age group was slightly greater than for the other age groups.

When asked why they do not allow extra riders, the reasons were reported as "no need for the tractor for transportation" (38.3%), "it is dangerous" (34.0%), and "it is forbidden" (27.7%). When the question "How often do you allow people on tractors?" was asked, 15 of the respondents answered sometimes, one said that he always allows people on tractor, and 44 said that they carried extra riders on tractors only if it was necessary, for example, if there were no other means of transportation, usually from rural areas to the towns.

The data on allowing extra riders were also analyzed according to the education level of respondents by chi-square test. The respondents were significantly different according to their education level ($p < 0.05$); 72.7% of the university graduates and 49.0% of the

Figure 3. Common use of farm tractors without ROPS and with extra rider on highway.

Table 14. Tractor operators' responses to the question "Do you allow extra riders?"

Age Group (years)	Count	Yes (%)	No (%)	Sometimes (%)
20-29	11	8	2	1
30-39	16	9	7	0
40-49	51	24	26	1
50-59	22	13	8	1
60 or older	7	3	4	0
Total	107	57 (53.3%)	47 (43.9%)	3 (2.8%)

Table 15. Most dangerous accidents according to the respondents' perceptions.

Accident Type	Percentage of Respondents (%)
Rollover	73.8
Crash	7.5
Runover	5.6
Rollover + Runover + Crash	6.5
Rollover + Crash	2.8
Rollover + Runover	0.9
Other	2.9
Total	100.0

primary school graduates allowed extra riders. When the question "Is it right to allow extra riders on tractors?" was analyzed according to education level, there was no significant difference among the respondents ($p > 0.05$).

Opinions about Accidents

The respondents were asked about the most important type of tractor incidents. They regarded tractor rollovers as the most dangerous type of incident (73.8%) (table 15), followed by crashes (7.5%) and runovers (5.6%). Some of the respondents stated that two or three of the accident types together were dangerous.

Health Issues

Two questions relating to health problems associated with long-term tractor use were asked of the respondents. None of the tractor operators used hearing protection, including earplugs and earmuff-type hearing protection, while working on the tractor; 64.5% of the respondents believed that working with the tractor did not cause any hearing loss. The other question was about spinal problems; 81.3% of the tractor operators had no spinal problems, while 66.4% believed that tractors may cause spinal problems.

Table 16. Answers to safety training questions.

Question	Yes (%)	No (%)	Sometimes (%)
Do you believe that the possibility of accident can be decreased if people are trained?	95.1	4.9	-
Have all workers including you and your family members been properly trained to safely operate tractors and equipment?	13.5	86.5	-
Do you read the tractor manuals?	57.7	35.6	6.7

Work Safety Training

Questions relating to work safety training were also asked of the respondents. The percentage of the respondents who believed that the possibility of an incident can be decreased if people are trained was 95.1%; however, interestingly, only 13.5% of the operators had training on work safety (table 16). This reveals an important contradiction between what the operators have and what they believe regarding work safety training. This result confirms the importance of training, and it reveals that the safety training level of the tractor operators is not satisfactory. Training programs are necessary for tractor operators. It was noted that more training programs should be made available for tractor operators by universities, government agencies, and non-profit organizations.

The respondents were asked about what can be done to prevent accidents. Most of the respondents stated that receiving training on safety and being careful are the most important factors in preventing accidents. Other factors include being aware of safety, performing regular machinery maintenance, and using the tractor slowly. It is crucial to find a means to maintain a safe workplace and safe machinery operation by using ROPS or ROPS-enclosed cabs, good tires, and good brakes, etc., to prevent accidents.

Conclusions

Few studies and limited statistical data are available on safety issues related to farm tractors and machinery in developing countries, including Turkey. This study was the first on the safety issues related to farm tractors in the Hatay province of Turkey. A questionnaire was conducted with 107 tractor operators using face-to-face interviews in different parts of the province. The conclusions of this study are as follows:

- A total of 101 incidents were reported. The most common accident type was tractor rollover (65.4%). Entanglement of body parts in moving machinery (14.8%) and crashes with other vehicles or objects (12.9%) were the other common accident types. The respondents regarded tractor rollovers as the most dangerous type of accident (73.8%).
- The number of fatal incidents was 26 out of 101, while 46 of the incidents resulted in serious injuries, and 29 caused slight or no injury. Eighteen out of 26 (69.2%) fatalities were caused by tractor rollovers. These data are in line with the results of studies conducted in other countries. Males constituted 95% of the victims killed or injured. The most commonly injured body parts were arms and legs.
- The leading cause of the incidents was found to be personal mistakes (60.4%), which might be reduced by training the tractor operators; therefore, it is crucial to initiate training programs.
- Only one of the respondents used a seatbelt while operating their tractor, even though 44.9% of the respondents stated that a seatbelt should be used. This is an

important contradiction between what the operators believe and what they do regarding seatbelt use.

- Even though most of the respondents (80.4%) stated that it was not right to use a tractor for transportation, half of them did so. Similarly, 53.3% of the respondents allowed extra riders on their tractor, although 87.9% of them stated that it is not right to allow extra riders on tractors.
- Even though Turkish law requires ROPS, the percentage of tractors with ROPS (19.6%) or ROPS-enclosed cabs (5.6%) was very low. Additionally, 41.3% of the tractors had shade covers, and 33.6% had no shade cover or ROPS. Shade covers have thin profiles and are not sturdy enough to provide rollover protection. It is crucial to force tractor operators to use ROPS or ROPS-enclosed cabs.
- Only 13.5% of the operators had training on work safety, while 95.1% of the respondents believed that the possibility of accidents can be decreased if people are trained.

In summary, this study provides insight into the current situations and attitudes of tractor operators in the Hatay province of Turkey. The findings indicate that the operators are not sufficiently aware of safety issues; they need to be informed about the benefits of ROPS and seatbelt use; and they need to be warned about the possible risks of carrying extra riders and of driving farm tractors on highway for transportation purposes.

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