



Analysis of On-Road Farm Tractor Accidents in Hatay Province of Turkey from 2000 to 2015

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ABSTRACT

Agriculture is usually considered among the three most hazardous sectors together with construction and transportation. Study results report that about half of the incidents in agriculture are related to machinery and half of those incidents are related to tractors. Also, the major source of injuries and fatalities was tractor rollovers and runovers. It is crucial to study the previous farm tractor accidents and draw conclusions to reduce the fatality and injury. In this study, data concerning on-road farm tractor accidents were studied covering the years of 2000 to 2015. A total of 177 accidents occurred during the study period and 28 of them caused fatality as 149 of them resulted in injury. In total, 29 victims were killed and 407 victims were injured summing the total number of victims to 436. In fatal accidents, most of the incidents (42.9%) were caused by tractor rollovers while in injury accidents, crashing with another vehicle constituted the majority of the incidents (38.9%). Most of the fatal accidents (78.6%) and injury accidents (55.7%) occurred in village roads. Two out of three victims in both fatal and injury accidents were males. 64.3% of the fatal accidents and 77.9% of the injury accidents took place in daytime. Almost one-third (35.7%) of the fatal incidents occurred at night. 26.6% of all incidents occurred in the Altinozu district while 18.6% of all accidents occurred in the month of June. The data were also analyzed in terms of other factors including tractor type, weather condition, road surface condition, number of vehicles involved in the incident, time (hour) of incident, operator age, and operator education level.

Keywords: Farm tractor, Safety, Accident, Fatality, Injury, Hatay, Turkey

INTRODUCTION

Agriculture is considered among the most three hazardous sectors together with construction and transportation (Lundqvist 1996). In several countries, the fatal accident rate in agriculture is double the average for all other industries (ILO 2000). Franklin *et al.* (2001) stated that the fatality rate in agriculture was four times higher than the rate of other industries in Australia in 1989–1992. According to Lundqvist (1996), 51% of agricultural workers, 46% of construction workers, and 37% of transportation workers feel themselves at risk in their work environment.

Machinery such as tractors and harvesters has the highest frequency and fatality rates of injury in agriculture (ILO 2000). Wilkins *et al.* (2003) reported that approximately half of the fatal agricultural injuries were related to tractors and at least half of these fatal injuries were due to tractor overturns.

Rollover protective structures (ROPS) are used to create safe working conditions for tractor operators in case of tractor rollover. The use of ROPS in farm tractors has a significant effect in decreasing the fatality. If there is ROPS and the seatbelt is fastened, the incident is expected to be non-fatal for the tractor operator. Whitman and Field (1995) indicated that ROPS were undervalued by senior farmers; while a majority of them (88%) accepted ROPS' effectiveness, only 42% had ROPS on their primary tractors. Springfield *et al.* (1998) stated that the use of ROPS increased from 6% to 93% as the fatalities significantly decreased in their 30-year study period in Sweden. Loring and Myers (2008) reported that number of tractors with ROPS increased from 38% in 1993 to 51% in 2004 in the US; however, this has not been sufficient to decrease the rate of tractor overturn deaths and incentive programs targeting older farm operators and low-income farms are suggested to increase ROPS use. Hard and Myers (2011) found that states with the highest percentage of ROPS on tractors generally had lower fatality rates for tractor overturns in the US. Myers and Hendricks (2010) reported that tractor overturn fatality rates declined by 28.5% between 1992 and 2007 in the US and tied this reduction partially to the increased prevalence of ROPS on farm tractors.

Seatbelt use on tractors has also been studied by many researchers. Myers *et al.* (2006) studied tractor rollover incidents and the presence of seatbelts and stated that if the seatbelt was fastened on ROPS-equipped tractors, only minor injuries were observed on the tractor operator in an overturn.

Many studies have been conducted on safety issues with farm machinery in developed countries where researchers used statistical data or collect data through questionnaires. However, most developing countries do

not have a statistical database for farm-related injuries. Javadi and Rostami (2007) classified the causes of incidents as 53% personal mistakes and 40% both personal and mechanical causes in Iran and stated that tractors and rotating parts were the main causes in machinery-related incidents. Patel *et al.* (2010) conducted a survey in India covering 1996-2000 and reported that out of 106 injuries, 57 injuries were related to farm machinery.

As in most developing countries, limited data are available on incidents in agriculture in Turkey. Gölbaşı (2004) studied 880 tractor injury incidents occurred in 1990-2001 and reported that the most common accident type was rollovers (60%). Oz (2005) conducted a questionnaire study with 250 farmers in the Aegean region of Turkey and reported that the most common incident types were rollovers (27%), crash (%26), and collision (%22). Akbolat *et al.* (2007) studied tractor and farm machinery incidents from 1995 to 2003 in the Isparta province of Turkey and stated that most important accident types were crashes (57.6%), rollovers (35.8%), and running off the road (4.4%). 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 and tractor overturn was the cause of 37.2% of the deaths.

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 utilization is 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.

Very limited statistical data on farm tractor incidents are collected by government agencies mainly by Turkish Statistical Institute (TurkStat) in Turkey. These data included the number of traffic accidents causing material loss, injury, and death according to vehicle type, including farm tractors on roads. However, no official statistical data are available on incidents in the farm work environment.

Only one research study is available on the incidents involving farm tractors and machinery in the Hatay province of Turkey. Gorucu Keskin *et al.* (2012) conducted a questionnaire study in which a total of 101 incidents were reported by 77 of the 107 operators. Most of the incidents were due to tractor rollovers (65.4%) as 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 (Gorucu Keskin *et al.* 2012).

The objective of this work was to study the characteristics of on-road tractor injury incidents in the Hatay province of Turkey during the period of 2000 to 2015 to assist the authorities to take precautions to prevent or reduce the incidents.

MATERIALS AND METHODS

Study Area

Agriculture is a crucial sector in Turkey producing a wide range of products including grains, pulses, fruits, vegetables and livestock and providing employment to nearly 23% of the total in 2012 (Berk 2013). The cultivated area is very large (24.5 million ha); however, the average farm size is only 5.9 ha which is well below than EU and US averages (17.4 and 18.0 ha respectively) (Berk 2013). Farms in Turkey are mostly specialized in field crop production (25.7%), mixed crop and livestock production (21.8%) and fruit and vineyards (19.8%) (Berk 2013).

The current study covered the Hatay province of Turkey. Hatay is one of the 81 provinces and located in the mid-south of Turkey. It has a total land area of 5,867 km² (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 products include 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 province has slightly different climatic conditions and land characteristics. Some areas of the province close to the Amanos Mountains have sloped land, making tractor operations risky, while areas in the Amik Plain in the center of the province are flat.



Farm Tractor Accident Data

Government agencies mainly the Turkish Statistical Institute (TurkStat) reports statistical data on farm tractor incidents on roads in Turkey annually. Data on tractor accidents on-roads and on farms according to the provinces are not available. In this paper, the total annual farm tractor accident data in Turkey from 2004 to 2013 were obtained from the web site of the institute (TurkStat 2004-2013) and included in this paper (Table 1). Since no data were available on provinces in Turkey, local authorities were contacted to obtain data for Hatay province. In general, there are two governmental authorities in Turkey responsible for recording traffic accidents. Police force is responsible for the accidents within the city limits while gendarmerie is responsible for the ones in the rural areas. Branches in Hatay province of both authorities were contacted to obtain the farm tractor accident data. This paper includes the analysis of the on-road farm tractor accident data obtained from the Hatay Provincial Gendarmerie Authority.

RESULTS AND DISCUSSION

Farm Tractor Accidents in Turkey

The total annual on-road farm tractor accident data in Turkey from 2004 to 2013 were given in Table 1 (TurkStat 2004-2013). In 2009, the number of farm tractors was 1,073,538 in Turkey and the number of total farm tractors involved in a fatal or injury accident on road was 1020 (TurkStat 2011b). During the period of 2004 to 2013, on average, 1903 on-road farm tractor accidents were recorded (Table 1). 79 of these accidents resulted in fatality while 1201 of them resulted in an injury. Also, during the same period, on average, 40 drivers were killed and 504 drivers were injured annually. It should be noted that these are the recorded accidents; in some cases, the incidents were not reported to the authorities and therefore not recorded. In addition, it should be noted that these accidents are the ones occurred on roads and do not include the accidents on farms or field conditions.

Table 1. Total annual on-road farm tractor accidents in Turkey (TurkStat 2004-2013).

Year	Number of tractors having an accident	Number of tractors resulting fatality	Number of tractors resulting injury	Number of drivers killed	Number of drivers injured
2004	2584	54	1012	23	350
2005	2830	72	1007	39	346
2006	3399	59	1025	29	355
2007	1092	63	1029	27	377
2008	961	45	916	10	351
2009	1020	58	962	36	794
2010	1069	59	1010	26	370
2011	1110	55	1055	28	395
2012	1224	59	1165	25	449
2013	2910	270	2640	160	1254
Mean	1903	79	1201	40	504

Farm Tractor Accidents in Hatay Province

Data concerning on-road farm tractor accidents obtained from the Hatay Provincial Gendarmerie Authority were analyzed in the study. The data included the accident recordings from the years of 2000 to 2015 in MS Excel spreadsheet. The accident data were originally organized based on the incident date (day-month-year), incident time, district, fatality/injury, accident type, number of vehicles involved, tractor type (two or four wheel), place of accident (road type), weather condition, road surface condition, age and gender of the victims, and education of the operator. The data were reorganized and tables and figures were created in MS Excel spreadsheet software.

Number of on-road farm tractor accidents and number of victims killed and injured in Hatay during 2000-2015 were given in Table 2 based on the fatality or injury type. A total of 177 accidents occurred during

this time period and 28 of these accidents caused fatality as 149 of them resulted in injury (Table 2). In total, 29 victims were killed and 407 of them were injured summing the total number of victims to 436.

Table 2. On-road farm tractor accidents in Hatay from 2000 to 2015.

Year	Fatal Accidents	Injury Accidents	Total Accidents	Victims Killed	Victims Injured	Total Victims
2000	2	5	7	2	15	17
2001	2	6	8	2	15	17
2002	4	10	14	4	29	33
2003	0	6	6	0	9	9
2004	0	2	2	0	3	3
2005	3	3	6	3	4	7
2006	1	5	6	1	7	8
2007	0	6	6	0	18	18
2008	1	5	6	1	15	16
2009	3	12	15	3	84	87
2010	3	9	12	3	24	27
2011	3	8	11	4	13	17
2012	0	12	12	0	18	18
2013	3	10	13	3	26	29
2014	1	22	23	1	55	56
2015	2	28	30	2	72	74
Total	28	149	177	29	407	436

Type of the on-road farm tractor accidents in Hatay from the year 2000 to 2015 was given in Table 3. In fatal accidents, most of the incidents (42.9%) were caused by tractor rollovers (Table 3). On the other hand, in injury accidents, crashing with another vehicle constituted the majority of the incidents (38.9%). Similar results were reported by other researchers on the cause of tractor accidents. Gölbaşlı (2004) reported that the most common accident type was rollovers (60%). Oz (2005) reported that the most common tractor incident types were rollovers (27%), crash (%26), and collision (%22). Akbolat *et al.* (2007) stated that most important accident types were crashes (57.6%) and rollovers (35.8%). Dogan *et al.* (2010) reported that tractor overturn was the cause of 37.2% of the deaths. Gorucu Keskin *et al.* (2012) reported that most of the incidents (65.4%) were due to tractor rollovers in Hatay province. The accident data used in this study did not have the information on ROPS availability on the tractors involved in the accidents. The use of ROPS in farm tractors has a significant effect in decreasing the fatality. Gorucu Keskin *et al.* (2012) reported that 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 in Hatay province.

Table 3. Type of the on-road farm tractor accidents.

Accident Type	Rollover	Crashing to Vehicle	Hitting an Object	Falling	Runover	Running off Road	Total
Fatal	12	7	0	5	3	1	28
	42.9%	25.0%	0.0%	17.9%	10.7%	3.6%	100.0%
Injury	40	58	3	11	10	27	149
	26.8%	38.9%	2.0%	7.4%	6.7%	18.1%	100.0%

Venue of the on-road farm tractor accidents in Hatay from the year 2000 to 2015 was given in Table 4. It was observed that majority of the fatal accidents (78.6%) and the injury accidents (55.7%) occurred in village roads (Table 4). Village roads are usually unpaved, curvy, and sloped which increase the chance of accident. In addition, it was seen that about one-fourth (24.8%) of the injury accidents were on highways. Farm tractors are often used as a transportation means on highways and this increases the likelihood of an accident. In a survey study conducted by Gorucu Keskin *et al.* (2012), 50.5% of the respondents (54 out of 107) stated that they use

their tractor for transportation on highways and rural roads. Farm tractors are not designed for transportation on highways. Every year, on average, 1903 on-road farm tractor accidents were recorded throughout Turkey on roads and highways (Table 1) (TurkStat 2004-2013). In one dramatic incident occurred in the month of June in 2009 in Reyhanli district, workers riding on an agricultural trailer attached to a farm tractor had an accident resulting in injury of 46 workers.

Table 4. Venue of the on-road farm tractor accidents.

Accident Type	Highway	Village Road	Street	Alley	Forest Road	Total
Fatal	2	22	3	1	0	28
	7.1%	78.6%	10.7%	3.6%	0.0%	100.0%
Injury	37	83	23	2	4	149
	24.8%	55.7%	15.4%	1.3%	2.7%	100.0%

Gender of the victims killed and injured in on-road tractor accidents in Hatay from 2000 to 2015 was also studied and presented in Figure 1. It was found out that, on average, two out of three victims in both fatal (69.0%) and injury (60.7%) accidents were males (Figure 1).

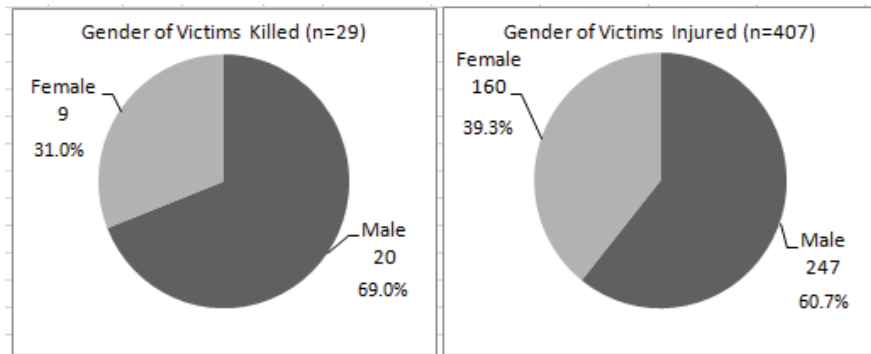


Figure 1. Gender of the victims killed and injured in on-road tractor accidents.

Occurrence time of the on-road tractor accidents resulting in fatality and injury in Hatay from 2000 to 2015 was shown in Figure 2. It was seen that 64.3% of the fatal accidents and 77.9% of the injury accidents took place in daytime. Almost one-third (35.7%) of the fatal incidents occurred at night. Problems with lighting system of the tractors reduce the visibility by other vehicles making them vulnerable for accidents.

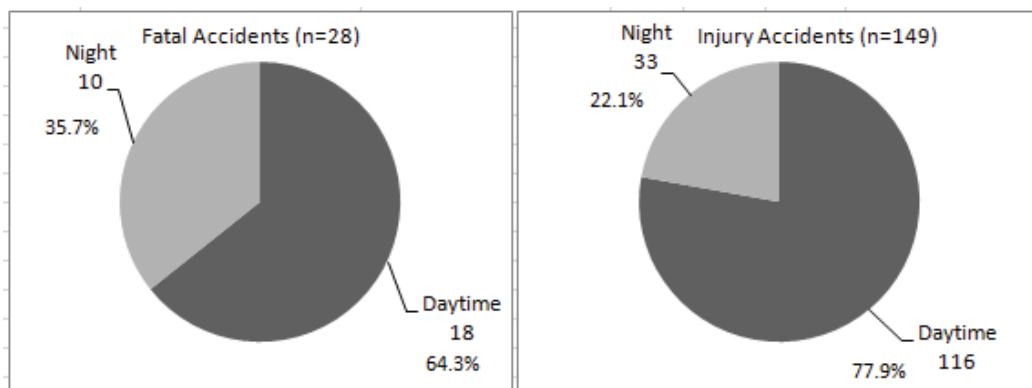


Figure 2. Time of the on-road tractor accidents causing fatality and injury.

Distribution of the tractor accidents based on the districts where they occurred in Hatay from 2000 to 2015 was visualized in Figure 3. It was found out that about 26.6% (47 out of 177) of all incidents occurred in

the Altinozu district. Also, 35.7% of the fatal accidents and 24.8% of the injury accidents took place in this district. This district is located on a sloped area and this may be the main reason of this finding.

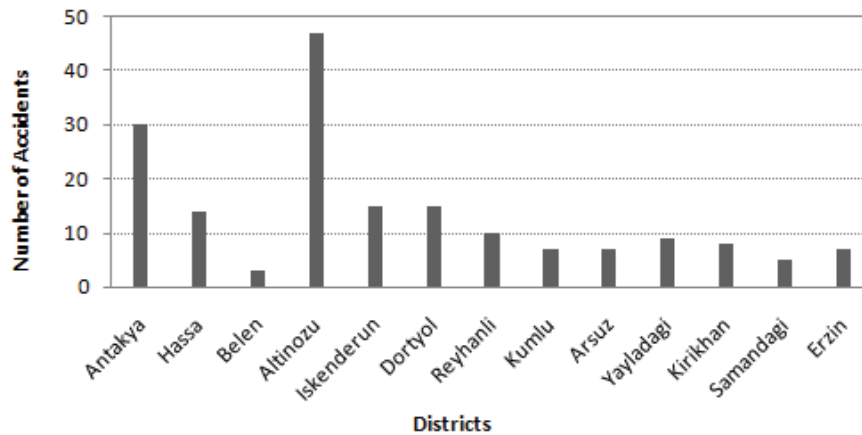


Figure 3. Distribution of the tractor accidents based on the districts where they occurred.

Month of all on-road tractor accidents (n=177) including both fatal and injury accidents in Hatay from 2000 to 2015 is shown in Figure 4. It was seen that 18.6% of all accidents (33 out of 177) occurred in the month of June. This month corresponds with the time of cereal crop (mainly wheat) harvesting and planting of the second crop corn and cotton. Therefore, agricultural activity is very intensive in this month increasing the farm tractor traffic leading to fatality and injury incidents on roads.

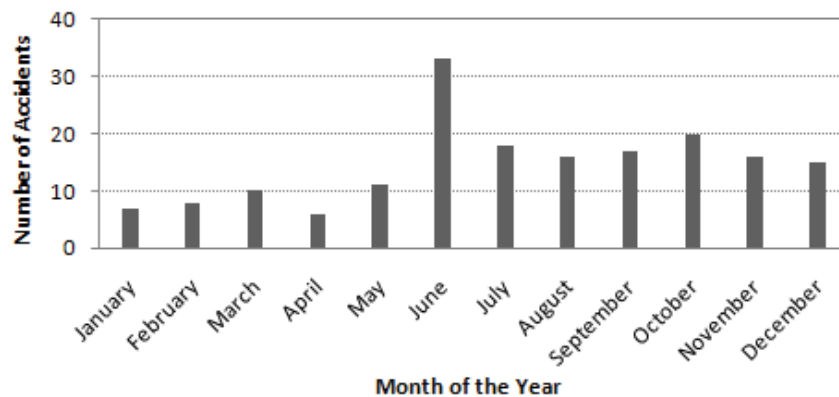


Figure 4. Month of the all on-road tractor accidents.

Day of all on-road tractor accidents (n=177) including both fatal and injury accidents in Hatay from 2000 to 2015 was also studied and illustrated in Figure 5. As can be seen from the figure, there is no significant difference in the number of farm tractor incidents according to the different days of the week even if Wednesday and Sunday has slightly higher number of incidents.

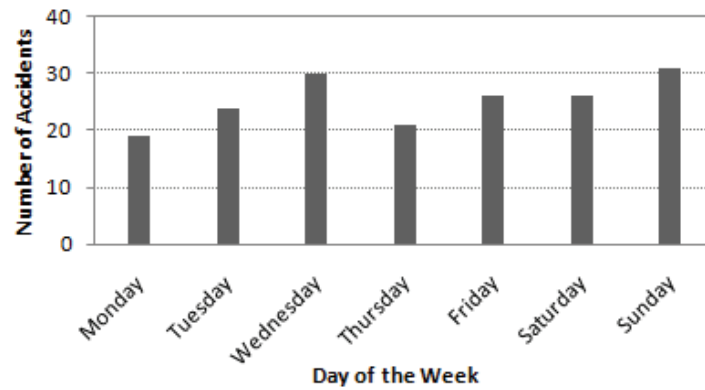


Figure 5. Day of the all on-road tractor accidents.

Type of the tractors involved in on-road accidents (n=177) including both fatal and injury accidents in Hatay from 2000 to 2015 was given in Figure 6. Majority of the tractors (92.1%) involved in fatal and injury accidents were four-wheel tractors. In recent years, in Hatay province similar to other provinces in Turkey, two wheel tractors are converted into a transport vehicle called “pat pat” by adding a small cart. This vehicle has increasingly been used to transport people and goods. Unfortunately, this vehicle is not appropriate to be used in roads and highways. Many accidents involving this type of vehicles have increasingly been reported in recent years.

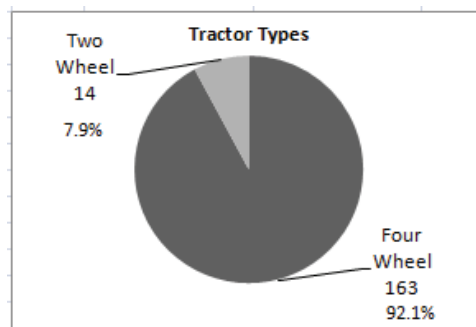


Figure 6. Type of the tractors involved in the on-road tractor accidents.

The accident data used in the study were also analyzed in terms of other factors including weather condition, road surface condition, number of vehicles involved in the incident, time (hour) of incident, operator age, and operator education level. Regarding the weather condition, 88.1% of all accidents occurred in clear sky conditions while 7.9% took place in cloudy weather. Concerning the road surface condition, 92.1% of all accidents occurred in dry road surface conditions while 7.9% took place in wet road surface. As regards to the number of vehicles involved in the incident, 59.3% of the all accidents involved in one vehicle while 39.0% of them involved two vehicles. As of the time (hour) of occurrence, incidents were concentrated in the morning, noon and afternoon hours. In addition, about 87.6% of the tractor operators involved in a fatal or injury accident had primary school education. Regarding the age group of the operators involved in a fatal or injury accident, the age group of 41-45 (16.4%) and the age group older than 55 (15.3%) were slightly dominant than other age groups.



CONCLUSIONS

This study dealt with the analysis of the data concerning on-road farm tractor accidents obtained from the Hatay Provincial Gendarmerie Authority from the years of 2000 to 2015 and the findings and conclusions of the study are listed below:

- A total of 177 accidents occurred during the period of 2000-2015 and 28 of them caused fatality as 149 of them resulted in injury. In total, 29 victims were killed and 407 of them were injured summing the total number of victims to 436.
- In fatal accidents, most of the incidents (42.9%) were caused by tractor rollovers. On the other hand, in injury accidents, crashing with another vehicle resulted in majority of the incidents (38.9%).
- Majority of the fatal accidents (78.6%) and the injury accidents (55.7%) occurred in village roads.
- Two out of three victims in both fatal and injury accidents were males.
- It was seen that 64.3% of the fatal accidents and 77.9% of the injury accidents took place in daytime.

Almost one-third (35.7%) of the fatal incidents occurred at night.

- It was found out that about 26.6% (47 out of 177) of all incidents occurred in the Altinozu district. Also, 35.7% of the fatal accidents and 24.8% of the injury accidents took place in this district.
- It was found out that 18.6% of all accidents (33 out of 177) occurred in the month of June.
- Majority of the tractors (92.1%) involved in fatal and injury accidents were four-wheel tractors.
- The accident data used in this study were also analyzed in terms of other factors including weather condition, road surface condition, number of vehicles involved in the incident, time (hour) of incident, operator age, and operator education level.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of Hatay Provincial Gendarmerie Authority that provided the farm tractor accident data.

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ULUDAĞ ÜNİVERSİTESİ
ZİRAAT FAKÜLTESİ DERGİSİ

The Journal of Agricultural
Faculty of Uludag University

Cilt 30

Volume

Sayı Özel Sayı

Number Special Issue

2016