



## Original Article

Nonfatal Occupational Injuries in Norwegian Farmers<sup>☆</sup>Kristin Svendsen<sup>1,\*</sup>, Oddfrid Aas<sup>2</sup>, Bjørn Hilt<sup>2,3</sup><sup>1</sup> Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology (NTNU), Trondheim, Norway<sup>2</sup> Department of Occupational Medicine, St. Olavs University Hospital, Trondheim, Norway<sup>3</sup> Department of Occupational Medicine, Department of Public Health and General Practice, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

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## ABSTRACT

**Background:** Agriculture ranks among the most dangerous trades worldwide. There is, however, still a lack of knowledge on nonfatal injuries in agriculture. The aim of this study was to describe the nature and occurrence of nonfatal injuries in farmers in two counties in central Norway.

**Methods:** A questionnaire was sent to 7,004 farmers in Norway. We asked for information about the respondents and the farm, whether the farmer had had work-related injuries on the farm during the past 12 months, and details about the incidence and seriousness of the injury.

**Results:** A total of 2,699 respondents gave a response rate of 42%. Of the respondents, 249 (9.2%) reported one or more work-related injuries. The most usual cause of injury involved an animal, and >75% of these happened inside the outbuilding. Among these, 17.5% had a consequence of sick leave or a more serious result. When all the accidents were analyzed by stepwise logistic regression, only the variables: works alone, has >3,500 stipulated working hours at the farm, and the type of production were statistical significant explanatory variables for having an injury.

**Conclusion:** Incorporating safety aspects to a greater extent in the design and construction of outbuildings would make a substantial contribution to injury prevention in agriculture.

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## 1. Introduction

Agriculture ranks among the most dangerous trades worldwide. According to estimates by the International Labor Organization, at least 170,000 agricultural workers are killed each year which means that workers in agriculture run twice the risk of dying on the job compared to workers in other sectors [1]. In Norway every fourth workplace fatality happens in agriculture, even though <3% of the working population works in this sector [2]. In addition, agricultural workers also suffer serious nonfatal injuries with accidents related to animals, together with machinery and falls, being the most common [3,4]. Earlier studies have indicated that better-designed facilities could contribute to the prevention of many injuries [5]. A recent Swedish study has pointed out three main themes that have an impact on risk and safety when handling animals, including the facilities [4].

An earlier Norwegian study showed that farming was the trade with the highest number of person injuries per million working hours in Norway [6]. Studies from other countries have shown that ~10% of farmers have had an accident during 1 year [7–9]. Even though tractors are the cause of almost 50% of the fatal injuries in Norway [2], it has been pointed out in an early Finnish study that the chain of causation probably is different for fatal injuries and nonfatal personal injuries [10]. There is, however, apart from some scattered information, still a lack of knowledge on the incidence and nature of nonfatal injuries in agriculture. There is therefore an urgent need for more knowledge on the occurrence, mechanisms and causes of all accidents in farming in order to prevent injuries and fatalities in the future [11].

In Norway, a regional department of the Farmers' Union, The Farmers' Association for health, safety and environment (HSE) Services, and the Labour Inspection Authority had already in 2003,

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together with a national insurance company (Gjensidige), declared a vision of zero accidents in agriculture. This project is a follow-up that will try to contribute to the realization of that vision. The study was performed in two counties in the middle part of Norway. These two counties are regarded as representative for most farmers in Norway, because the distribution of the type of production in these two counties is the same as the distribution of production types for the whole country [12].

The aim of this study was to describe the nature and occurrence of nonfatal injuries in farmers in two counties in the middle part of Norway.

## 2. Methods and materials

The survey was conducted in 2010 among all farmers in two counties in the central part of Norway. A questionnaire was sent to 7,004 addresses obtained from the Norwegian Agricultural Producers Register. In this register all farmers who had applied for economic support from the government during the past year are included, which means practically all active farmers in Norway. For those who had an e-mail address (3,700 persons) the questionnaire was sent electronically with the possibility to also reply online, whereas for the others, a paper version of the questionnaire was sent by mail (3,304 persons) with a prepaid response envelope. In the questionnaire we asked for background information about the respondents and the farm, and whether the farmer had had work-related injuries on the farm during the past 12 months. Specific background information that was inquired about was: age, family situation, having work outside the farm or being a full-time farmer, working alone on the farm or having an assistant, and having co-production with other farmers. The farmers were also asked if they had joined a voluntary health and safety program and if they had access to an occupational health service. Moreover, we asked if the farmers had an organized locum for vacations and/or illness, the number of working hours per year at the farm, the field area available to the farm, and about the main additional production types at the farm. The variables included in the questionnaire that were entered into a stepwise logistic regression are shown in Table 1. If the farmer reported having had an injury during the past

12 months, the questionnaire also inquired about where the injury happened, how it happened, and what object, if any, was involved in the injury. In addition, we wanted to know about the seriousness of the injury in terms of days of sick leave, if the victim had consulted a medical doctor or was hospitalized, and if the injury had other long-lasting consequences. The question about days for sick leave was given in intervals and the questions on medical consultation, hospitalization, and long-lasting consequences could be answered as yes or no. In the questionnaire we deliberately gave no specific definition of the term injury. The responders decided themselves what to report. The wording of the question was: "Have you, during the last 12 months, experienced an injury related to farm work?"

### 2.1. Statistical analysis

The data were analyzed with IBM SPSS statistics version 19.0. (IBM, Armonk, N.Y) Odds ratios for the outcome injury were determined by logistic regression in relation to the different determinants. When a farmer had reported more than one injury, all injuries were analyzed as separate cases. We used a stepwise procedure for initial model selection, including independent variables that showed statistical significance at  $p < 0.05$ . All potential risk factor variables available from the questionnaire given in Table 1 were used for model selection. Independent variables included in the final model were works alone, stipulated working hours at the farm of  $>2 \times 1,750$  hours/year, and has cattle on the farm. Other calculations were done by crosstabs and frequencies tables.

### 2.2. Ethical considerations

The study was approved by the REC central (Regional Committee for Medical and Health Research Ethics; approval ref. 2010/1048). The participation was voluntary and all persons gave their informed consent prior to their inclusion in the study. Written information about the project was given to every participant, also stating that he/she could withdraw from the study at any time.

## 3. Results

For 450 of the 7,004 persons in the study population, the e-mail or postal addresses that we received from the Production Register were not correct, and, they were therefore not reached. There were 76 persons who reported back that they were retired or had quit farming for non-accident-related reasons, and another 31 who reported that they were not farmers. In addition, 86 responded that they did not want to participate, and 10 of the returned questionnaires lacked signed consent to participate in the study, and were thus excluded. There were 2,699 persons who answered the questionnaire and consented to participate, giving a response rate of 42%. Among the responders, 11% were female, which is in accordance with the sex distribution in the whole population, and the rest were male, except for 12 who did not report sex. Some background data for the respondents are given in Table 2.

Of the respondents, 249 (9.2%) reported one or more work-related injuries during the past 12 months, with a total of 304 injuries. There were 23 farmers who reported two injuries and 16 with three injuries. Most of the injuries happened in the groups aged 40–49 years and 50–59 years, but the highest proportion of injuries was among the youngest farmers aged 20–29 years. The distribution of injuries by age and seriousness is given in Table 3. There were no sex differences in the injury rate. The distribution of the 304 injuries sorted by the cause of injury and some other determinants is given in Table 4. As we can see from Table 4, the most

**Table 1**  
Variables used in logistic regression

Independent variable		
Age	Continuous	
Family situation	Married/has a co-habitant	Lives alone
Has other work	Has work outside the farm	Full-time farmer
Working alone	Has an assistant	Works alone
Has co-production with other farmers	Yes	No
Has joined the voluntary health and safety program	Yes	No
Has access to an occupational health service	Yes	No
Has organized locum for vacations and/or illness,	Yes	No
No. of stipulated yearly working hours at the farm	$<2 \times 1,750$ h/y	$>2 \times 1,750$ h/y
Field area available to the farm	Continuous	
Production type	Cattle Swine Corn Vegetables Forest	No cattle No swine No corn Not producing vegetables Not forest

**Table 2**

Background data for 2,699 farmers who responded to a questionnaire on farm injuries

	Male (2,383)	Female (305)
Age (y; mean and min–max)	51.0 (20–88)	46.5 (23–71)
Married/cohabiting	2006 (84.2)	251 (82.3)
Full-time farmer	1277 (53.6)	131 (42.9)
Co-production with other farmers	260 (10.9)	32 (10.6)
Works mainly alone	1680 (70.5)	85 (27.8)
Stipulated working hours/year on the farm <1,750	975 (40.6)	60 (19.7%)
Organized locum	1141 (47.9)	149 (49.0)
Access to occupational health services	1115 (46.8)	149 (49.0)
Any formal HSE education	1401 (58.8)	155 (50.8)
Main-production on the farm:		
Cattle	103 (46.3)	140 (46.2)
Swine	119 (5.0)	12 (4.0)
Sheep	293 (12.3)	61 (20.1)
Corn	601 (25.2)	50 (16.5)
Forestry	62 (2.6)	3 (1.0)
Has had one or more injury	219 (9.2)	30 (9.8)

Data are presented as n (%).

HSE, health, safety and environment; max, maximum; min, minimum.

usual cause of an accident involved an animal. Also, >75% of the animal-related injuries happened inside an outbuilding, and among these, 17.5% had a consequence of sick leave or a worse result. Only 14.4% of the animal-related injuries happened in the fields and only 4.1% in a courtyard. Approximately 50% of the cases also reported the mechanism of the accident. Of those, 51% of the animal-related accidents were caused by kicks, hits, and gores (data not shown). Among those accidents that involved animals, 81% happened to farmers with a main production of cattle, and 10% in farmers with a main production of swine (data not shown). Even though there were several animal-related accidents among the swine farmers, these accidents did not have such serious consequences as for the cattle farmers. For cattle farmers 30.3% of the injuries involving animals had a consequence of sick leave or a more serious result, whereas 10% of these injuries among swine farmers had the same consequence (data not shown). For all the injuries seen together, 63% led to a medical consultation and/or hospitalization, and 29% led to sick leave for >1 week. The consequences of the injury for the whole group and for the different type of production are given in Table 5.

The second most frequent cause of accidents involved a tractor or other heavy machinery on the farm. The consequences of these accidents were, however, more serious with >40% leading to sick leave or a more serious consequence compared to <30% of the injuries caused by animals. Table 6 gives the consequences of the injuries in relation to the different causes.

There were 94% of the accidents in outbuildings that happened among the farmers with animal production (main or by-production). Among these accidents, 54.3% were caused by an animal (data

not shown). Details of the locations of the 304 accidents are given in Table 7.

Regarding the time of year, most injuries happened during spring and fall when activity is usually at its highest on Norwegian farms.

When all the accidents were analyzed by the stepwise logistic regression in an attempt to find explanatory variables, only the variables: works alone, has >2 farmer-years at the farm ( $2 \times 1,750$  hours), and the type of production were significant explanatory variables for having an accident. The results of the logistic regression are given in Table 8.

The continuous variable age had an odds ratio = 0.99 ( $p = 0.065$ ).

#### 4. Discussion

We found an increased injury rate in livestock farmers compared to others, in particular for dairy, beef, and swine farming. This is in accordance with other studies [13,14]. Handling of animals was most frequently involved when an injury occurred, with injuries involving heavy machinery in second place. In the regression analysis, having cattle on the farm was also the independent determinant that had the highest odds ratio for having an injury. Machine-related injuries were, however, more serious in the sense that the victims more often sought medical attention and to a greater extent suffered work disability and sick leave. We know from previous studies that accidents involving tractors or other heavy machinery are responsible for most agricultural fatalities in Norway (~50%) [2]. During the past two decades a great deal of effort has been made to reduce the most serious tractor accidents, for example, legally required rollover protection and the installation of seat belts in all new tractors.

Regarding the injuries in which animals were involved, most happened inside an outbuilding. These animal-related injuries also had the most serious consequences, in particular, for cattle farmers. Out of ~44,000 farmers in Norway, seven persons died because of accidents involving animals from 2001 to 2009 [2]. Such accidents represent 5% of the fatal accidents in agriculture in the past 20 years [2]. Together with our results, these figures make clear the importance of the prevention of injuries involving animals. There is, for instance, great potential for injury prevention in designing outbuildings that are safer for animal handling [4,5]. Examples of such preventive measures are cattle corals, squeeze chutes, and head gates. In Norway, farm outbuildings often lack such equipment, which makes animal handling a risky operation. Since 2010, it has been mandatory to apply for permission to build farm outbuildings. If the building is <1,000 m<sup>2</sup>, the farmer is allowed to be the only responsible constructor, whereas for outbuildings >1,000 m<sup>2</sup>, the farmer needs a professional builder who is responsible for the whole project [15]. Architects and engineers who draw and design outbuildings for farms do not have special

**Table 3**

Distribution of injuries by seriousness and age of victims

	Age (y)*					
	20–29	30–39	40–49	50–59	60–69	>70
No. in the age group	60	341	824	806	502	70
Had 1 or more injury	9 (15)	27 (7.9)	91 (11.0)	76 (9.6)	32 (6.4)	6 (8.6)
Medical certificate/reported sick	5 (8.3)	11 (3.2)	39 (4.7)	27 (3.3)	12 (2.4)	2 (2.9)
Reported sick >7 d or more serious consequences	4 (6.7)	10 (2.9)	32 (3.9)	25 (3.1)	13 (2.6)	0
Hospitalization	1 (1.7)	3 (0.9)	23 (2.7)	14 (1.7)	10 (2.0)	2 (2.9)

Data are presented as n (%).

\* Age missing for 96 farmers in the whole group and eight farmers with reported injury.

**Table 4**  
Distribution of 304 injuries sorted by involved cause, place of injury, and seriousness of accident

Accident involves	No. of injuries with this involvement	No. of injuries that happened inside an outbuilding	Injuries that happened inside an outbuilding with consequence of sick leave or more serious result	Injuries that happened outside an outbuilding with consequence of sick leave or more serious result
Animal	97 (31.9)	73 (75.3)	17 (17.5)	11 (11.3)
Hand equipment/chain saw	42 (13.8)	20 (47.6)	3 (7.1)	11 (26.2)
Big machinery including tractor	79 (26.0)	14 (17.7)	3 (3.8)	28 (35.4)
Ladder/slippery floor	29 (9.5)	15 (51.7)	5 (17.2)	8 (27.6)
Chemicals	4 (1.3)	2 (50.0)	1 (25.0)	0
Other causes or cause not given	53 (17.5)	20 (37.7)	7 (13.2)	16 (30.2)
Total no. of injuries	304	144	36	74

Data are presented as *n* (%).

**Table 5**  
Consequences of injury for all farmers and for each group of farmers

Nos. and Consequences	All farmers	Cattle farmers	Other animal production	Vegetables and corn	Other production
No. of farmers in the group	2,699*	1,243	533	694	213
No. of farmers with one or more reported injuries	249 (10.3)	163 (13.1)	47 (8.8)	25 (3.6)	12 (5.6)
No. of injuries	304	196	59	29	18
Could perform ordinary work without problems	57 (18.8)	42 (21.4)	8 (13.6)	2 (6.9)	5 (27.8)
Could perform ordinary work, but with problems	116 (38.0)*	67 (34.2)	26 (44.1)	15 (51.7)	7 (38.9)
Had a medical certificate/was reported sick	96 (31.6)*	69 (35.2)	18 (30.5)	7 (24.1)	2 (11.1)
Long-lasting consequences	13 (4.3)	6 (3.1)	3 (5.1)	2 (6.8)	2 (11.1)
Absence from work:					
0.5 d	2 (0.6)	1 (0.5)	1 (1.7)	–	–
0.5–1 d	3 (1.0)	1 (0.5)	2 (3.4)	–	–
2–7 d	22 (7.2)	14 (7.1)	7 (11.9)	–	1 (5.6)
8–29 d	44 (14.4)	33 (16.8)	5 (8.5)	6 (20.7)	–
30 d–6 mo	34 (11.1)*	26 (13.3)	4 (6.8)	3 (10.3)	–
>6 mo	10 (3.3)	5 (2.6)	3 (5.1)	1 (3.4)	1 (5.6)
Had contact with a medical doctor	137 (44.9)*	87 (44.4)	30 (50.8)	15 (51.7)	4 (22.2)
Was hospitalized	53 (17.4)	35 (18.8)	9 (15.3)	3 (10.3)	6 (33.3)

\* 16 of all farmers and two farmers with an injury did not give main production type.

**Table 6**  
Cause of injuries, and consequences of the given causes\*

	Animal involved	Big machinery involved	Hand tools involved	Ladders involved	Slippery ground involved	Other causes
Total no. of injuries	90	77	46	18	16	46
Sick leave or a more serious consequence	24 (26.6)	32 (41.5)	14 (30.4)	4 (26.7)	8 (50)	22 (47.8)
Sick leave for >7 d	21 (23.3)	27 (35.1)	12 (26.1)	6 (33.3)	8 (50)	15 (32.6)
Had contact with a medical doctor	29 (32.2)	33 (42.9)	29 (63.0)	9 (50)	10 (62.5)	23 (50)
Was hospitalized	11 (12.2)	19 (24.7)	6 (13.3)	3 (16.6)	3 (18.7)	9 (19.6)

Data are presented as *n* (%).

\* Cause was not specified for 11 injuries.

**Table 7**  
Distribution of 304 injuries by location of injury

Location	All injuries	Cause of injuries			
		Animal	Hand equipment	Heavy machinery	Ladder/slippery floor
Inside the cowshed	138 (45.4)	73 (75.3)	19 (45.2)	12 (15.2)	14 (48.3)
In the silo	6 (2.0)	0	1 (2.1)	2 (2.5)	1 (3.1)
Out in the courtyard	54 (17.8)	4 (4.1)	7 (16.7)	32 (40.5)	3 (10.3)
Out in the field	37 (12.2)	14 (14.4)	0	17 (21.5)	3 (10.3)
In the forest	25 (8.2)	2 (2.1)	10 (23.8)	5 (6.3)	1 (3.4)
In road traffic	3 (1.0)	0	0	2 (2.5)	0
Other places or place not given	41 (13.7)	4 (4.1)	5 (12.2)	9 (12.0)	7 (24.6)
Total no. of injuries	304	97	42	79	29

Data are presented as *n* (%).

**Table 8**

Odds ratio (OR) with *p* determined by logistic regression for the explanatory variables in relation to the outcome variable injury

Variable	OR	<i>p</i>
Works alone	1.35	<0.05
Stipulated working hours at farm (>3,500 h)	1.54	<0.01
Has cattle as main or additional production	1.8	<0.001

training for optimizing the health and safety aspects in the building [15]. Most of the farmers are aware of the injury risk related to animal handling, but they often think that they know their own animals, and that this kind of accident will not happen on their farm. Consequently, health and safety conditions are often not considered at all during the design and building process [15]. Designing and equipping the cow house for the safe handling of cattle is also a matter of economy, and, as there is not much money in small farms today, this often forces the choice of cheap solutions [15]. A study has also shown that higher levels of economic worries have been associated with the absence of safety features on farms, and that the financial situation on the farm appears to contribute to the decisions that farmers make about safety [16].

Statistics from the Labor Inspection Authority of Norway show that 20% of the work-related fatalities in agriculture are falls inside barns/outbuildings [2]. This is also in accord with our study showing that a large share of the accidents caused by ladders or slippery floors happened inside an outbuilding. By improving safety aspects in the design of such outbuildings, there is thus an obvious opportunity for the prevention of such accidents. A possible measure for increasing safety in buildings could be some kind of economic incentives for safe design and installation of safety devices in the outbuildings.

In conclusion, we found that 32% of work-related injuries among farmers happened while handling animals. Most of these happened inside outbuildings. Incorporating safety aspects to a greater extent in the design and construction of such buildings could make a substantial contribution to injury prevention in agriculture.

### Conflicts of interest

The authors have no conflicts of interest to declare in this study.

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