

## Variation in Eurostat and national statistics of accidents in agriculture

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**Abstract.** Agriculture is known as a hazardous industry worldwide, although there are great challenges in enumerating the size of the workforce and numbers of accidents at work. The aim of the study was to characterize variation in agricultural accident statistics in European countries and opportunities to improve collection and reporting of accident data in agriculture on the national and European levels. This study explored the incidence of fatal (FA) and non-fatal work accidents (NFA) in agriculture (excluding forestry and fishing) in selected European countries, using Eurostat and national sources in 2013. Eurostat reported highest NFA rates (per 100,000 workers) in Finland (5331) and lowest in Greece (5). The highest FA rate was reported in Malta (51), while zero fatalities were reported in Estonia, Greece, Luxembourg, Slovenia, Sweden and Iceland. Eurostat and national statistics differed in many cases. Some variations were observed in European and national statistics. Germany reported 89 fatalities (rate 2.3/100,000) in Eurostat and 160 (rate 16.3/100,000) in national sources. Poland, with a similar land area and five times more farms and workers as Germany, reported only 4 fatalities in agriculture in Eurostat. The Estonian Labour Inspectorate (2013) registered 785 NFAs per 100,000 agricultural workers, while the rate in Eurostat was more than twice as high (1914/100,000). Finland and Sweden with similar agricultural structures had a ten-fold difference in NFA rates in Eurostat; Finland 5,331 and Sweden 554 per 100,000 workers. These examples illustrate the large variation in agricultural accident statistics due to: a) farm structure, b) use of reference populations, c) under-reporting, d) different inclusion/exclusion criteria and e) interpretation by users. Some inconsistencies are structural due to lacking social insurance schemes for farmers, family labour and undocumented workers. Some inconsistencies could be addressed by better implementation of ESAW harmonizing rules. Alternative methods, such as standardized surveys, could be considered to augment Eurostat statistics.

**Key words:** agriculture, farm, worker, accident, injury, quality, statistics.

### INTRODUCTION

Agriculture is one of the most hazardous industries worldwide, along with construction and mining (ILO, 2015). While it is difficult to obtain recent estimates for occupational injuries, illnesses and exposures in agriculture, numerous studies and

reports have documented the hazardous nature of the agriculture industry (Rautiainen & Reynolds, 2002; European Communities, 2004; Donham & Thelin, 2016). ILO (2004) estimated that 335,000 fatal work accidents occurred worldwide in a year, and over 50% (170,000) of them involved agricultural workers. About 1,300 NFAs and 4.2 FAs were registered per 100,000 farm workers on average each year between 2008 and 2013 in European countries. The highest FA rates in agriculture, forestry and fishing were registered for Malta (46), Austria (31) and Ireland (23), and the lowest for Poland (1.8) and Finland (2.5) (Thomson, 2016). In many cases, similar neighbouring countries have showed over ten-fold differences in agricultural accident rates. There is great variation in published rates between countries, which raises questions about the accuracy of the reporting of accidents in agriculture.

Collection and reporting of agricultural injury and illness data is challenging worldwide, particularly for self-employed farmers. For instance, in the United States, national surveys of NFAs in agriculture have suffered from measurement errors, untimeliness and insufficient data quality (Patel et al., 2017). However, reliable, timely statistics are necessary for understanding the financial and social burden of accidents at work, as well as for designing preventive efforts and monitoring if progress is being made (COWI, 2013).

Improvements in data collection and quality of statistics are important objectives in the European Commission strategic framework on health and safety at work 2014–2020 (European Commission, 2019). Improving statistics of work-related accidents, injuries, illnesses and exposures in agriculture is also a major goal of the current ‘Safety Culture and Risk Management in Agriculture’ COST Action (SACURIMA, 2019).

This study was conducted as part of the SACURIMA COST Action, and it aimed to characterize variation and inconsistencies in agricultural accident statistics in selected European countries and opportunities to improve collection and reporting of accident data in national and Eurostat statistics.

## **MATERIALS AND METHODS**

### **Data sources and content**

The European Union collects data on accidents at work using a harmonized ‘European Statistics on Accidents at Work (ESAW)’ methodology, first published in 1990 (ESAW, 2008). ESAW uses the NACE Rev. 2 system for the ‘Statistical Classification of Economic Activities in the European Community’, managed by Eurostat (NACE Rev 2, 2008). Eurostat publishes data on FA and NFA by economic sector using the NACE methodology. Sector A includes agriculture, forestry and fishing and A.1 includes agriculture alone, consisting of crop production, animal production, support activities and hunting. A.1 data for agriculture are reported in 39 sub-categories at three levels.

Agriculture, forestry and fishing is one of the nine themes in the Eurostat database (available at: <https://ec.europa.eu/eurostat/data/database>). Detailed information for agriculture is available on farm structure, economics, production, types of farms, environmental measures and labour. Accidents at work are reported in Eurostat database under ‘Cross cutting topics > Quality of employment > Safety and ethics of employment > Safety at work’ in several tables with options to define specific search criteria by geography, NACE sector, sex, year and unit (number, incidence rate).

EU member states have a legal requirement to send data described in ESAW to Eurostat by the end of June each year. New countries have been added to Eurostat during 1995–2012 including Croatia, Iceland, Norway, Switzerland, Montenegro and Serbia (ESAW, 2008; Eurostat, 2019). Eurostat publishes work accident statistics at the national and European aggregate levels to enable comparisons between countries, regions and economic sectors.

One important definition in ‘ESAW 3.6. Statistical population’ states that ‘Member States are required to report on ‘employees’. Reporting on other employment types (self-employed, family members, students and others) is voluntary.’ Agriculture in most countries is based on small family farms, and therefore the majority of agricultural workers are likely to fall under ‘voluntary’ reporting in ESAW.

An accident at work is defined in ESAW as ‘a discrete occurrence in the course of work, which leads to physical or mental harm’, augmented with additional inclusion and exclusion criteria. The data include fatal accidents and non-fatal accidents involving 4 or more calendar days of absence from work. If the accident does not lead to the death of the victim it is called a ‘non-fatal’ (or ‘serious’) accident. A fatal accident at work is defined as an accident which leads to the death of a victim within one year of the accident (ESAW, 2008).

National sources for ESAW include national accident insurance systems, private insurance carriers for accidents at work and other relevant national authorities (incl. labour inspectorates). As an exception, the accident statistics for the Netherlands are based on survey data.

The accident data are presented as numbers, percentages, incidence rates and standardised incidence rates for non-fatal and fatal accidents at work, either for EU aggregates, countries or certain breakdowns by dimensions such as age, sex etc.

- Numbers correspond to a simple count of all non-fatal and fatal accidents for the entirety or certain breakdowns of the data;
- Percentages represent shares of breakdowns;
- The incidence rate of non-fatal or fatal accidents at work is the number of non-fatal or fatal accidents per 100,000 persons in employment;
- The standardized incidence rates of non-fatal or fatal accidents at work aim to eliminate differences in the structures of countries’ economies.

National sources of information vary by country; some have national social security and accident insurance (workers’ compensation) systems that cover practically all workers in the agriculture sector, also self-employed farmers. Some countries rely on a mix of insurance-based data and self-reporting, and some use surveys to augment other data sources. The national sources cited in this article were found on the internet, publications of national authorities, agricultural journals and scientific articles, or by requests to national experts in the field. The statistics of farm structure and accidents are presented for all Eurostat member countries. National data to validate Eurostat information are presented for selected countries participating in the SACURIMA COST Action.

### **Methods of data analysis**

This study presents descriptive statistics on holdings (farms), labour and fatal and non-fatal accidents in agriculture in EU countries. The data were extracted from Eurostat and augmented with national data sources. The study focused on NACE category A.1 –

agriculture, excluding forestry and fishing. The year 2013 was the most recent year available for some data, and therefore, all statistics are presented for the year 2013.

Descriptive statistics on holdings (farms, n) include the count of holdings, utilized agricultural area (area used for farming, ha), total area and standard output (€); each presented by country as total and average per farm. The share (%) of utilized agricultural area out of total area was calculated for each country to illustrate the proportion of agricultural vs. non-agricultural (incl. forest production) economic activity. These indicators describe the general size of the national agriculture sector, as well as the geographic and economic size of an average agricultural holding in each member country. The data were extracted from Eurostat table [ef\_kvftaa].

The labour force is described using the number of persons in employment and the Annual Work Units (AWU), which combines full-time and part-time workers converting the amount of labour into full-time equivalent numbers. The amount of family labour is described as persons and AWU, and the amount of total labour, including family and non-family labour, is described as 'Regular labour force', similarly in persons and AWU. The share (%) of the family labour out of total regular labour force (in AWU) was calculated for each country. The data were extracted from Eurostat table [ef\_olfftecs]. Annual work unit (AWU) is defined as full-time equivalent employment corresponding to the number of full-time equivalent jobs, i.e. as total hours worked divided by the average annual number of hours worked in full-time jobs within the economic territory (Eurostat, DG AGRI, 2019). AWU corresponds to the work performed by one person who is occupied on an agricultural holding on a full-time basis. If the national provisions do not indicate the number of hours, then 1,800 hours are taken to be the minimum annual working hours: equivalent to 225 working days of eight hours each. As the volume of agricultural labour is being calculated on the basis of full-time equivalent jobs, no one person can therefore represent more than one AWU. This constraint holds even if it is known that someone is working on agricultural activities for more than the number of hours defining full-time in the Member State concerned (Eurostat, 2018).

The incidence of non-fatal and fatal accidents was described using annual numbers and rates of fatal and non-fatal accidents (injuries) that occurred in 2013. Incidence rates for both fatal and non-fatal accidents are expressed in Eurostat as accidents per 100,000 workers in employment. Accident data were extracted from Eurostat tables [hsw\_n2\_01] and [hsw\_n2\_02]. The term 'accident' was used in this paper as it is still used in Eurostat and many European countries to describe an 'injury' or 'acute injury event'. These terms are commonly preferred in the injury prevention field.

The following calculations were performed for each country; 1) to quantify the size of the reference population used in the accident rate calculations and 2) to compare the reference population to the published regular labour force. If the reference population ratio deviates considerably from 1.0, there is a concern about how the incidence rate was calculated, as published in Eurostat.

1:  $\text{Number of accidents} * 100,000 / \text{incidence rate} = \text{Reference population};$

2:  $\text{Reference population} / \text{Regular labour force (AWU)} = \text{Reference population ratio}.$

Finally, national data sources were explored to validate the accuracy of Eurostat fatal and non-fatal accident reporting by comparing Eurostat numbers and rates to those found in national sources. These comparisons were performed primarily for Germany, Finland, Estonia and the neighbouring countries (incl. Ireland, Norway, Sweden) where

the authors have access and familiarity with national sources in local languages. In addition to national reports, normally published in the language of the member state, personal contacts with health and insurance authorities etc. were utilized to find out national information about non-fatal and fatal accidents for the selected year, 2013.

## RESULTS

### Number and size of agricultural holdings

According to Eurostat, EU (28) countries had approximately 10.8 million farms in 2013. Family farm is the most common farm type in Europe; approximately 90% of farms (10.1 million) are family farms, utilizing about half of the farmland in Europe.

Table 1 shows the numbers of holdings, utilized agricultural area, total area and standard output, in total and per farm, for the EU 28 and each Eurostat member country. The average size of utilized agricultural land (area used for farming) was 16 hectares (ha) per farm, and the total area (including forest and other land) was 20 ha per farm. The share of utilized agricultural land out of total was 82% on average, ranging from 19% in Norway to 97% in Belgium. In addition to Norway, the share of arable land out of total land was less than 50% also in Finland, Sweden and Austria where most farms involve significant forest production. Most Eastern and Southern European countries have large numbers of very small (micro) farm holdings specialized in horticulture. For example, Poland had 1.4 million farms and 14.4 million hectares of arable land accounting to 10.1 ha of arable land per farm. The ‘Farm Structure Survey’ shows a general trend of decreasing farm numbers and increasing arable land areas per farm in EU countries (Eurostat, 2013). Besides farm sizes, there is also great variability in the Standard Output by country and by farm on average. The countries with the largest farm output were France, Germany and Italy, and the smallest were Malta, Luxembourg and Cyprus. The largest standard outputs by farm were found in the Netherlands, Belgium and Denmark, and the smallest in Romania, Malta and Lithuania.

**Table 1.** Holdings, area and output in agriculture, Eurostat 2013

Country	Total number of holdings	Utilized agricultural area, ha		Total area, ha		Standard output	
		Total	Holding, avg.	Total	Holding, avg.	Total (million Euros)	Holding, avg. (Euros)
EU (28)	10,838,290	174,613,900	16	213,749,800	20	331,105	30,550
Austria	140,430	2,726,890	19	5,815,840	41	5,671	40,383
Belgium	37,760	1,307,900	35	1,350,200	36	8,407	222,643
Bulgaria	254,410	4,650,940	18	5,608,980	22	3,336	13,113
Croatia	157,440	1,571,200	10	1,728,100	11	2,029	12,887
Cyprus	35,380	109,330	3	123,810	3	495	13,991
Czech Rep	26,250	3,491,470	133	5,076,430	193	4,447	169,410
Denmark	38,280	2,619,340	68	2,920,610	76	9,580	250,261
Estonia	19,190	957,510	50	1,229,420	64	676	35,227
Finland	54,400	2,282,400	42	5,786,690	106	3,398	62,463
France	472,210	27,739,430	59	29,264,400	62	56,914	120,527
Germany	285,030	16,699,580	59	18,305,150	64	46,252	162,271

Table 1 (continued)

Greece	709,500	4,856,780	7	5,062,500	7	8,103	11,421
Hungary	491,330	4,656,520	9	7,048,760	14	5,578	11,353
Ireland	139,600	4,959,450	36	5,277,990	38	5,013	35,910
Italy	1,010,330	12,098,890	12	15,933,790	16	43,794	43,346
Latvia	81,800	1,877,720	23	3,058,780	37	990	12,103
Lithuania	171,800	2,861,250	17	3,125,370	18	1,919	11,170
Luxembourg	2,080	131,040	63	137,790	66	314	150,962
Malta	9,360	10,880	1	11,980	1	97	10,363
Netherlands	67,480	1,847,570	27	2,008,870	30	20,498	303,764
<sup>a</sup> Norway	43,270	996,270	23	5,372,090	124	3,410	78,807
Poland	1,429,010	14,409,870	10	16,487,480	12	21,797	15,253
Portugal	264,420	3,641,590	14	4,625,700	17	4,509	17,052
Romania	3,629,660	13,055,850	4	14,661,380	4	11,990	3,303
Slovakia	23,570	1,901,610	81	3,067,090	130	1,812	76,877
Slovenia	72,380	485,760	7	902,160	12	1,009	13,940
Spain	965,000	23,300,220	24	30,042,210	31	35,979	37,284
Sweden	67,150	3,035,920	45	6,424,370	96	4,679	69,680
United Kingdom	183,040	17,326,990	95	18,663,950	102	21,819	119,203

<sup>a</sup> - non-EU country.

The size of the farms, intensity of production, geography, climate and growing conditions are closely tied to the structure of the workforce, nature of work and injury and illness hazards.

### Labour force in agriculture

Eurostat reports labour force numbers by person, Annual Work Unit (AWU) and type of employment. Following are the AWU numbers for EU (28) countries by category: Family labour force (7,271,360), Regular non-family labour force (1,460,240), Total regular labour force (8,731,620), Non-family labour force working on non-regular basis (774,770) and Labour force directly employed by the holding (9,506,410), all expressed in Annual Work Units (Table 2). The workforce numbers counted in persons are more than twice as large as the numbers in AWU, indicating that a large proportion of the workforce in agriculture works on a part-time basis. As an example, the count of persons in EU (28) family labour force (20,199,360) was 2.8 times larger than the AWU count of family labour force (7,271,360). A nearly as large difference (2.5 times) was found in total regular labour force. The largest numbers of family labour were found in Romania, Poland and Italy and the smallest in Luxembourg, Malta and Estonia. Family labour's share of the total regular labour force was 75% in EU (28) countries combined, ranging from 27% in Czech Republic to 97% in Slovenia.

The size of the labour force, counted as persons and AWU, as well as the share of family labour out of total labour in AWU are shown in Table 2.

**Table 2.** Labour force in Agriculture, Eurostat 2013

Country	Labour force, persons		Labour force, Annual Work Units (AWU)		
	Family	Regular labour force	Family	Regular labour force	Family's share of total (%)
EU (28)	20,199,360	22,205,300	7,271,360	8,731,620	75
Austria	308,670	337,580	92,920	107,740	86
Belgium	59,290	74,830	40,220	52,010	77
Bulgaria	499,690	557,670	245,090	298,380	82
Croatia	374,910	388,370	163,140	173,250	94
Cyprus	73,090	77,390	11,510	15,240	76
Czech Rep	49,420	132,130	27,070	101,070	27
Denmark	53,630	79,580	28,020	51,090	55
Estonia	30,900	44,220	10,240	21,550	48
Finland	101,030	120,020	42,480	52,990	80
France	491,050	907,080	296,680	640,480	46
Germany	529,290	706,260	322,920	466,830	69
Greece	1,213,420	1,238,490	395,300	412,450	96
Hungary	962,570	1,059,940	314,710	400,020	79
Ireland	252,270	269,510	150,480	160,610	94
Italy	1,992,690	2,139,060	617,150	696,240	89
Latvia	153,610	173,920	67,810	81,770	83
Lithuania	264,070	297,950	114,850	142,450	81
Luxembourg	3,790	4,950	2,410	3,380	71
Malta	14,310	14,870	3,960	4,380	90
Netherlands	133,320	193,140	88,730	131,750	67
<sup>n</sup> Norway	106,940	124,900	33,930	40,860	83
Poland	3,480,250	3,558,710	1,799,160	1,866,450	96
Portugal	565,830	626,390	250,060	298,550	84
Romania	6,488,130	6,577,930	1,386,370	1,451,870	95
Slovakia	39,090	80,020	13,960	49,030	28
Slovenia	198,000	200,630	77,290	79,470	97
Spain	1,437,190	1,782,690	485,960	661,050	74
Sweden	108,740	130,710	40,620	55,670	73
United Kingdom	321,110	431,260	182,250	255,850	71

<sup>n</sup> non-EU country.

### Number and rate of fatal and non-fatal accidents

In 2013, Eurostat reported 366 FA and 135,260 NFA in EU (28) countries for the NACE A.1 Agriculture sector (without forestry and fishing). Table 3 shows the counts and rates of FA and NFA in EU (28) and Eurostat member countries. The corresponding rates were 4.14 for fatal and 1,528 for NFA per 100,000 workers. Italy, Germany and Austria had the highest fatality counts while Estonia, Greece, Luxembourg, Slovenia, Sweden and Iceland reported zero fatalities. Very low rates (below 1/100,000) were reported for Poland, Switzerland and Germany. The highest fatality rates were reported in Malta, Austria and Norway. Germany, Italy and Spain had the highest numbers of NFA, accounting for about 79% of all accidents in EU countries. The remaining 21% were spread between 25 EU member countries. The highest rates of NFA were reported in Finland, Italy and Spain, and the lowest in Greece, Poland and Bulgaria.

**Table 3.** Number and rate of fatal and non-fatal accidents, Eurostat 2013

Country	Fatal accidents		Non-fatal accidents		Reference population**	
	Number	Rate*	Number	Rate*	Reference population**	Ratio***
EU (28)	366	4.14	135,260	1528	8,849,256	1.01
Austria	49	26.14	3,968	2117	187,426	1.74
Belgium	1	5.12	315	1612	19,538	0.38
Bulgaria	2	3.19	34	54	62,650	0.21
Croatia	2	3.07	314	483	65,070	0.38
Cyprus	1	9.52	18	171	10,504	0.69
Czech Rep	16	13.74	2,558	2196	116,480	1.15
Denmark	8	12.72	995	1583	62,872	1.23
Estonia	0	0	338	1914	17,658	0.82
Finland	4	5.27	4,048	5331	75,939	1.43
France	1	8.67	403	3494	11,534	0.02
Germany	76	2.33	60,693	1858	3,265,979	7.00
Greece	0	0	25	5	457,038	1.11
Hungary	6	3.53	487	287	169,846	0.42
Iceland	0	0	16	408	3,919	-
Ireland	12	12	1849	1848	100,035	0.62
Italy	81	10.94	26,819	3621	740,752	1.06
Latvia	3	23.8	35	278	12,606	0.15
Lithuania	4	4.19	96	101	95,484	0.67
Luxembourg	0	0	123	2170	5,668	1.68
Malta	1	51.26	7	359	1,951	0.45
Netherlands	3	1.85	3,169	1892	167,478	1.27
<sup>n</sup> Norway	8	19.2	135	324	41,629	1.02
Poland	4	0.24	831	49	1,699,734	0.91
Portugal	11	2.59	2,773	654	424,162	1.42
Romania	12	13.22	49	54	90,774	0.06
Slovakia	7	13.25	481	910	52,848	1.08
Slovenia	0	0	65	121	53,870	0.68
Spain	24	4.38	19,319	3524	548,158	0.83
Sweden	0	0	370	554	66,744	1.20
Switzerland	1	0.71	1,316	934	140,848	-
United Kingdom	38	14.59	5,078	1949	260,520	1.02

\* Rate (accidents / 100,000 persons in employment) (ESAW, 2019); \*\* Reference population = Number of accidents \* 100,000 / incidence rate; \*\*\* Ratio = Reference population / reported Regular labour force; <sup>n</sup> non-EU country.

There are large differences in work accident counts and rates between countries with similar agricultural structures, such as number of workers, average farm size, utilized agricultural area or farming activities and even reported output coming from nature of production. For example, Germany and Poland have similar sizes of arable land. The numbers of farms and workers in Poland are about five times larger compared to Germany. Yet, the NFA rate in Germany was 1,858; nearly 40 times higher than the rate in Poland (49). While Germany reported 76 fatalities in agriculture, Poland reported 4 and France reported only one. The Nordic countries have relatively similar numbers of farms, farm sizes and production, yet the NFA rates were 324 for Norway, 554 for Sweden and 5,331 for Finland; about ten-fold difference between Finland and the two



neighbouring countries. Ireland at one extreme has a reported output of €1,000/utilized ha – whereas the Netherlands is the other end of the scale at over €11,000. My guess is that this reflects the nature of the production, for example a lot of unirrigated grass-fed grazing - versus a significant amount of intense horticulture and barn-raised animals.

The rate of work accidents is generally higher among male workers. Females had a higher rate in four countries, nearly four times higher rate in Estonia, and somewhat higher rates in Denmark, Ireland and Sweden.

There is large fluctuation in annual accident counts and rates in some countries. For instance, the NFA count for Finland showed large fluctuation by year; the NFA counts were 4,350, 586 and 4,048 for the years 2011, 2012 and 2013, respectively (Eurostat table [hsw\_n2\_01]). The FA rate for Germany was 13.84 in 2008, but then abruptly dropped to a level fluctuating between 1.64 and 3.36 during 2009–2016 (Eurostat table [hsw\_n2\_02]).

A back-calculation of the reference populations as described in Methods was performed to detect errors or unusually large deviations, potentially due to recording or calculation errors or weighting used in rate calculations. Germany's reported fatality rate in Eurostat was 2.33/100,000 workers in 2013. However, the reference population would need to be 3,265,979 to have the published 2.33/100,000 fatality rate and 76 fatalities. The actual Eurostat regular labour force count (AWU) was reported as 466,830 in 2013. The fatality rate for Germany would be 16.3/100,000 when calculated with the regular labour force number as denominator – a seven-fold difference compared to the Eurostat published rate. Large deviations were found in other countries as well. France only reported one fatality in agriculture, but the rate was reported as 8.67/100,000. With this rate, the reference population would be 11,534, while the actual reported regular labour force was 907,080 in 2013 – nearly 80-fold difference.

The counts and rates of fatal and non-fatal accidents and the back-calculated reference populations and ratios are presented in Table 3.

### **National and Eurostat statistics**

Eurostat and national FA and NFA counts and rates were compared for selected countries. Germany reported 160 fatalities in national statistics and 89 in Eurostat; these numbers are for the NACE A (agriculture, forestry and fishing combined).

A Spanish survey of Arana et al. (2010) found, that only 62% of the fatal accidents were recorded by the Labour and Social Affairs Spanish Ministry (Ministerio de Trabajo y Asuntos Sociales, MTAS) in the years 2004–2008. Reasons for this difference were not investigated.

The Estonian Labour Inspectorate (LI) reported 785 non-fatal accidents per 100,000 agricultural workers while Eurostat reported 1914. The Estonian Statistics Agency (ESA) combines cases from LI and the Estonian Working Life Survey (ELFS) (Enn, 2018).

Finland's NFA counts for 2011, 2012 and 2013 were: 4,350, 586 and 4048, respectively. It is likely that 2012 count excludes self-employed farmers, insured by the Farmers Social Insurance Institution (Mela) as Mela (2019) reported 4,567 agricultural accidents in 2012 (including those that may not exceed 3 days of absence from work).

The Agricultural Social Insurance Fund (KRUS) in Poland registered 15,803 accidents resulting in health detriment or death among farmers in 2013 while Eurostat

shows 813 NFAs and 4 FAs, which in only about 5% of the total reported by the national insurance fund (KRUS, 2016).

## DISCUSSION

There are great challenges in collecting and reporting information on occupational injuries and illness. The challenges are worldwide; statistics are often incomplete due to under-reporting of injury and illness incidents, and incomplete coverage of workers, particularly those in the informal economy (Thomson, 2016; COWI, 2013; Karttunen & Rautiainen, 2013b; ILO, 2012). The majority of the workforce in agriculture consists of self-employed family labour that may not be covered by social insurance schemes with ability to report occupational injury and illness cases. ILO (2015) has estimated that agriculture employs 1.3 billion workers worldwide; half of the world's workforce; and that agriculture is one of the three most hazardous industries globally, along with construction and mining. In the United States, fatal accidents are quite well known (CFOI, 2019), but there is no national system to collect NFA information for farmers, as surveys conducted by national agencies have been discontinued (Patel et al., 2017). In Canada, Provinces have different data collection systems, and information on agricultural injuries and fatalities is collected periodically through volunteer efforts (CAIRS, 2019). In Europe, there is great variability in farm structure, working populations and accident data collection systems, including insurance, administrative and survey sources (ESAW, 2008; Eurostat 2019). There are no uniform data collection and reporting systems, making it possible to compare data between continents and countries with reasonable accuracy.

The current study focused on the variability and accuracy of agricultural accident (injury) and fatality statistics in Europe using Eurostat and national sources. The results show large variation in fatal and non-fatal accident rates in Eurostat statistics between countries. The Eurostat accident counts and rates can also vary widely in one country from year to year, and there are large differences in accident counts and rates between Eurostat and national sources for a given year.

The reasons for the variability are complex. Without in-depth investigation of national data collection and reporting systems, it is not possible to identify reasons for inconsistencies comprehensively. However, the current study identified some sources of variation, based on limited examination of Eurostat and national statistics. The identified sources of variation are discussed in the following.

### a) Differences in farm structure

Structural changes in agriculture, decreasing farm numbers and increasing farm sizes influence the economic and social well-being of the farming population, including the risk of FA and NFA (Leppälä, 2016). The numbers and sizes of holdings differ widely between Eurostat countries. These differences affect working conditions and the risk of accidents. Based on systematic reviews, greater farm area, income and number of workers on the operation; being owner/operator (vs. hired worker); being full-time farmer; living on (vs. off) the farm and raising livestock are among risk factors for agricultural injuries. Other factors, such as challenging social conditions, stress, depression, sleep deprivation and regular medication use also increase the risk of injury. There is conflicting evidence for other factors, such as off-farm work, marital status,

work experience, age, smoking and alcohol use (Jadhav et al., 2015, Jadhav et al., 2016). Greater forest area also increases the risk of injury among farmers (Karttunen & Rautiainen, 2013a).

Some of the variation in accident counts and rates between Eurostat member states could be explained by farm structure. Given the known risk factors, countries with large farms based on full-time family labour and significant livestock and forestry production should have similar high accident rates. However, Eurostat fatality counts and rates from three large advanced agricultural nations show clear inconsistencies: France (1 fatality, rate: 8.67/100,000), Germany (76 fatalities, rate: 2.33/100,000) and United Kingdom (38 fatalities, rate: 14.59/100,000). The differences in Eurostat accident rates can be more than ten-fold between similar countries in some cases. The effect of identified risk factors is much smaller, typically about two-fold increase in accident risk. Therefore, farm structure may explain some, but not nearly all of the variation in accident rates.

#### b) Selection of reference populations

Eurostat accident rates are based on 'persons in employment'. ESAW (2008) defines the statistical population as follows: 'Member States are required to report on 'employees'. The other employment types (self-employed, family members, students and others) are voluntary.' This definition is problematic for agriculture. The average share of family labour out of total labour in Eurostat countries was 75%. Therefore, reporting of accidents is voluntary for the vast majority;  $\frac{3}{4}$  of the workforce in agriculture.

Eurostat agricultural statistics provide labour force numbers by person and by Annual Work Unit (AWU) in the following categories: 1) Family labour force, 2) Regular non-family labour force, 3) Total regular labour force, 4) Non-family labour force working on non-regular basis and 5) Labour force directly employed by the holding. It is likely that for most countries, the FA and NFA counts exclude family labour. It is also possible that the reference population for rate calculations includes family labour, given the complexity how agricultural labour is counted, in persons and AWU.

We examined the published Eurostat FA and NFA rates, and back calculated the size of the reference population from the counts and rates for each Eurostat country. On the EU (28) level, our calculated reference population was 8,849,256; almost the same as the Regular labour force (in AWU), 8,731,620. Examination of the ratio: calculated reference population / Regular labour force (AWU) revealed that while the ratio was 1.01 for the EU (28), it varied widely from 0.02 (France) to 7.00 (Germany). This variation demonstrates that there are inconsistencies in the selection of reference populations for accident rate calculations. It is likely that in many countries, accidents are reported only for regular non-family labour, but rate calculations use Total regular labour force, Labour directly employed by the holding, or another version of the total labour force, resulting in significant under estimation of the accident rates in agriculture.

#### c) Under-reporting of work accidents

ESAW (2008) mandatory accident reporting to Eurostat is based on European Commission Regulations. The national ESAW sources include accident insurance of the national social security system, private insurance for accidents at work or other relevant national authorities (labour inspection etc.) or surveys.

Only few countries have statutory accident insurance schemes for self-employed farmers. Without incentive, such as insurance benefits, farmers are unlikely to report their injuries, even if reporting is mandatory. In some cases, there may even be real or perceived penalties for reporting accidents. Lack of accident insurance coverage for

family labour results in systematic underreporting of agricultural accidents. For example, Pinzke & Lundqvist (2011) found that as many as 90% of agricultural work accidents remained unreported in Sweden. This finding is in accordance with Eurostat NFA data: the rate was 554/100,000 in Sweden and 5,331/100,000 in Finland; a ten-fold difference although these neighbouring countries have quite similar geography and farm structures. The source of the difference is likely that Finland has a mandatory accident insurance scheme for practically all farmers and hired workers, and under reporting is not a major issue (Karttunen & Rautiainen, 2013b). Similar mandatory accident insurance does not exist in Sweden.

The ESAW definition of reportable accident, '4 or more calendar days of absence from work', is difficult to apply for family labour in agriculture. In most countries, there is no accident insurance that provides compensation for 'absence from work' for self-employed farmers. In case of an accident to a farmer, such 'absence from work' period remains undefined. Further, farmers regulate their own working hours, and they are likely to work in limited capacity in health situations where they would be 'absent from work', if working for an employer in another sector. This ESAW definition is likely to result in under-reporting of accidents to family labour in Eurostat statistics.

Migrant workers often work without permanent job contracts and their employment and work accident numbers are likely under-reported. Migrant workers (globally about 244 million people) often work in unsafe conditions, which leads to poor health, injuries and deaths at work. Their employers often evade responsibility to report and pay compensation for work injuries for the workers without permanent contracts (Sousa et al., 2010; Ronda-Perez et al., 2012; Moyce & Schenker, 2018).

#### d) Inclusion/exclusion criteria and weighting in national and ESAW reporting

Eurostat and national statistics may have different inclusion and exclusion criteria. As an example, Germany reported 160 fatalities in national statistics and much lower number (89) in Eurostat for agriculture, forestry and fishing combined. Request of information to the national authority revealed some reasons for the difference in national and Eurostat statistics. For instance, persons over 70 and under 18 years of age are included in national statistics but excluded from Eurostat.

The Estonian Labour Inspectorate (LI) reported a lower number (785) of non-fatal accidents per 100,000 agricultural workers than Eurostat (1914). The Estonian Statistics Agency (ESA) combines cases from LI and the ELFS (Enn, 2018). Estonia is one of 10 out of 31 countries that applies weights for non-fatal accidents. Data are weighted through three dimensions: calculation of design weights, non-response correction and calibration of non-response corrected weights. The weighting shows how many objects from the population the respondent represents. Due to the stratification the design weight depends on the inclusion probability. The design weight of the household is inversely proportional to the inclusion probability and it depends on the size of the stratum in the population and the number of units selected into the sample from the stratum (ELFS, 2013).

Inconsistencies can occur even if a country has good data. Some data may not be reported to Eurostat because reporting is 'voluntary' for family labour according to ESAW. Finland's NFA counts for consecutive years showed large differences, likely due to including or excluding self-employed farmers in different years.

Variation in national and Eurostat figures could result from inclusion or exclusion of commuting accidents, transportation accidents and accidents to seasonal and undocumented workers. These sources were not investigated in the current study.

One systematic problem has been that some Eastern European countries have not reported information about agricultural accidents in Eurostat at all in some years. For our selected year 2013, the data were complete for EU (28) countries while it is likely that under-reporting occurs for most countries.

e) interpretation by users

One common error in interpretation of accident statistics involves mixing the accident counts and reference populations when constructing accident rates. Users may present accident counts and rates for 'agriculture' while in fact, the counts and rates are calculated for agriculture, forestry and fishing combined. In other cases, users may construct accident rates for 'agriculture' by using the (bigger) number of accidents for the agriculture, forestry and fishing, sector, but using only agricultural population numbers as denominator. Given the complexity in retrieving Eurostat numbers and rates, and the added complexity from differing national data, it is very challenging for researchers and educators to obtain reliable and correct data.

## CONCLUSIONS

The European Statistics on Accidents at Work (ESAW) methodology was developed first in 1990, and it aims to harmonize work accident data collection in Europe. Agriculture sector, defined in the Statistical Classification of Economic Activities in the European Community (NACE) is included, but it is not possible to get an accurate picture of the work accident situation from Eurostat statistics, and hence these statistics are not helpful for making policy decisions to address hazards and risks in agriculture. This study identified great variation in reported fatal and non-fatal accident counts and rates in Eurostat and national sources. Sources of variation include differences in a) farm structure, b) use of reference populations c) under-reporting, d) inclusion/exclusion criteria and e) interpretation of data by users. Some inconsistencies are structural due to lacking social insurance schemes for farmers and family labour. Some could be addressed by better implementation of ESAW harmonizing rules, including clarification of including/excluding self-employed farmers, who form the majority of the agricultural workforce in most countries. Better regulation of work contracts in agriculture could prevent under-reporting of work accidents among migrant workers. Alternative methods, such as standardized surveys, could be considered to augment Eurostat statistics.

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## REFERENCES

- Arana, I., Mangado, J., Arnal, P., Arazuri, S., Alfaro, J.R. & Jarén, C. 2010. Evaluation of risk factors in fatal accidents in agriculture. *Span. J. Agric. Res.* **8**(3), 592–598.
- CAIRS. 2019. Canadian Agricultural Injury Reporting. Available at: <https://www.cair-sbac.ca/> Accessed March 12, 2019.
- CFOI. 2019. Census of Fatal Occupational Injuries. Bureau of Labor Statistics. Available at: <https://www.bls.gov/iif/oshcfoi1.htm> Accessed March 16, 2019.
- COWI. 2013. DG Employment, Social Affairs and Inclusion. Evaluation of the European Strategy on Safety and Health at Work 2007–2012. Final Report. Available at: <https://ec.europa.eu/social/main.jsp?langId=en&catId=151> Accessed March 16, 2019
- Donham, K.J. & Thelin, A. (ed.). 2016. *Agricultural Medicine: Rural occupational and environmental health, safety and prevention, 2<sup>nd</sup> edition*. Wiley-Blackwell, 600 pp.
- ELFS. 2013. Estonian Labour Force Survey 1995–2012. Methodology. Tallinn. <https://www.stat.ee/dokumendid/72595> Accessed July 19, 2019.
- Enn, A. 2018. Prevalence and dynamics of work accidents in Estonian agriculture. MSc Thesis. Tartu, 102 pp. [https://dspace.emu.ee/xmlui/bitstream/handle/10492/4357/Anni\\_Enn\\_MA2018.pdf?sequence=1&isAllowed=y](https://dspace.emu.ee/xmlui/bitstream/handle/10492/4357/Anni_Enn_MA2018.pdf?sequence=1&isAllowed=y) Accessed February 16, 2019.
- ESAW. 2008. Accidents at work. Available at: [https://ec.europa.eu/eurostat/cache/metadata/en/hsw\\_acc\\_work\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/en/hsw_acc_work_esms.htm) Accessed February 17, 2019.
- European Commission. 2019. EU Occupational Safety and Health (OSH) Strategic Framework 2014–2020. Available at: <https://ec.europa.eu/social/main.jsp?langId=en&catId=151> Accessed February 17, 2019.
- European communities. 2004. Work and health in the EU. A Statistical portrait. Data 1994–2002. (117 pages) Available at: <https://ec.europa.eu/eurostat/documents/3217494/5657469/KS-57-04-807-EN.PDF/d1c5fda3-290d-4265-8a96-1059628d2729> Accessed December 9, 2018.
- Eurostat. 2019. Your key to European statistics. Available at: <https://ec.europa.eu/eurostat/data/database> Accessed February 17, 2019.
- Eurostat, DG AGRI. 2019. Agricultural factor income per annual work unit (AWU). Available at: [https://ec.europa.eu/eurostat/web/products-datasets/-/sdg\\_02\\_20](https://ec.europa.eu/eurostat/web/products-datasets/-/sdg_02_20) Accessed July 18, 2019.
- Eurostat. 2018. Glossary: Annual work unit (AWU). [https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Annual\\_work\\_unit\\_%28AWU%29](https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Annual_work_unit_%28AWU%29) Accessed July 19, 2019.
- Eurostat. 2013. Farm Structure Survey, 2013. Available at: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Farm\\_structure\\_survey\\_2013\\_-\\_main\\_results](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Farm_structure_survey_2013_-_main_results) Accessed March 21, 2019.
- ILO. 2004. Towards a fair deal for migrant workers in the global economy. Available at: <http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/meetingdocument/kd00096.pdf> Accessed July 18, 2019.
- ILO. 2012. Improvement of national reporting, data collection and analysis of occupational accidents and diseases. Available at: [https://www.ilo.org/safework/info/publications/WCMS\\_207414/lang--en/index.htm](https://www.ilo.org/safework/info/publications/WCMS_207414/lang--en/index.htm) Accessed March 16, 2019.
- ILO. 2015. Agriculture: A hazardous work. Available at: <https://www.ilo.org/safework/areasofwork/hazardous-work/lang--en/index.htm> Accessed March 16, 2019.
- Jadhav, R., Achutan, C., Haynatzki, G., Rajaram, S. & Rautiainen, R. 2015. Risk Factors for Agricultural Injury: A Systematic Review and Meta-analysis. *J. Agromedicine* **20**(4), 434–49. doi: 10.1080/1059924X.2015.1075450

- Jadhav, R., Lander, L., Achutan, C., Haynatzki, G., Rajaram, S., Patel, K. & Rautiainen, R. 2016. Review and Meta-analysis of Emerging Risk Factors for Agricultural Injury. *J. Agromedicine* **21**(3), 1–14. <http://dx.doi.org/10.1080/1059924X.2016.1179611>
- Karttunen, J.P. & Rautiainen, R.H. 2013a. Occupational injury and disease incidence and risk factors in Finnish agriculture based on 5-year insurance records. *J. Agromedicine* **18**(1), 50–64. PubMed PMID: 23301890. doi: 10.5603/IMH.2016.0031
- Karttunen, J.P. & Rautiainen, R.H. 2013b. Distribution and characteristics of occupational injuries and diseases among farmers: a retrospective analysis of workers' compensation claims. *Am. J. Ind. Med.* **56**(8), 856–869. <https://doi.org/10.1002/ajim.22194>
- KRUS. 2016. Agricultural Social Insurance Fund (KRUS). Basic information. Warsaw, 52 pp.
- Leppälä, J. 2016. Systematic risk management on farms. Doctoral Dissertation. Department of Industrial Engineering and Management. Aalto University publication series 17/2016. *Aalto-yliopiston teknillinen korkeakoulu*. Espoo, 152 pp.
- Mela. 2019. Farmers Social Insurance Institute in Finland. MATA-compensation statistics. Available at: <https://www.mela.fi/>.
- Moyce, S.C. & Schenker, M. 2018. Migrant workers and their occupational health and safety. *Annu. Rev. Public Health* **39**, 351–365. doi: 10.1146/annurev-publhealth-040617-013714
- NACE Rev. 2. 2008. Statistical classification of economic activities in the European Community. Available at: <https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF/dd5443f5-b886-40e4-920d-9df03590ff91?version=1.0>. Accessed March 10, 2019.
- Patel, K., Watanabe-Galloway, S., Kofin, R., Haynatzki, G. & Rautiainen, R. 2017. Non-fatal agricultural injury surveillance in the United States: A review of national-level survey-based systems. *Am. J. Ind. Med.* **60**, 599–620. <https://doi.org/10.1002/ajim.22720>
- Pinzke, S. & Lundqvist, P. 2011. Occupational injuries in agriculture and forestry 2004. Swedish University of Agricultural Sciences. LTI-report 2011:44. Alnarp, Sweden (in Swedish).
- Rautiainen, R.H. & Reynolds, S.J. 2002. Mortality and morbidity in agriculture in the United States. *J. Agric. Saf. Health* **8**(3), 259–76. doi: 10.13031/2013.9054
- Ronda Pérez, E., Benavides, F.G., Levecque, K., Love, J.G., Felt, E. & Van Rossem, R. 2012. Differences in working conditions and employment arrangements among migrant and non-migrant workers in Europe. *Ethnicity & Health* **17**(6), 563–77. doi: 10.1080/13557858.2012.730606.
- SACURIMA. 2019. Safety Culture and Risk Management in Agriculture. COST Action 16123. Available at: <https://www.cost.eu/actions/CA16123/#tabs|Name:overview> <https://www.sacurima.eu/> Accessed February 17, 2019.
- Sousa, E., Agudelo-Suarez, A., Benavides, F.G., Schenker, M., García, A.M., Schenker, M., García, A.M., Joan Benach, J., Delclos, C., López-Jacob, M.J., Ruiz-Frutos, C., Ronda-Pérez, E. & Porthé, V. 2010. Immigration, work and health in Spain: the influence of legal status and employment contract on reported health indicators. *Int. J. Public Health* **55**(5), 443–51. doi: 10.1007/s00038-010-0141-8
- Thomson, K. 2016. Health and Safety in EU Agriculture. Presentation paper for the 160th EAAE Seminar 'Rural Jobs and the CAP'. Warsaw, 14 pp. Available at: [https://ageconsearch.umn.edu/record/249792/files/H\\_S%20Paper%20Thomson%20FinalS%20submitted.pdf](https://ageconsearch.umn.edu/record/249792/files/H_S%20Paper%20Thomson%20FinalS%20submitted.pdf) Accessed March 10, 2019.