

2.2 Tools and measures for safety culture in agriculture

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Objective

The second objective of COST Action 16123 Sacurima was to identify the knowledge, beliefs, attitudes, norms, competencies and perceptions of farmers regarding safety, health and risk management, to investigate the factors that determine their safety behaviours and practices. To achieve that objective, it was considered important to develop an adequate tool to measure these concepts in a reliable and valid way. While indeed previous research has addressed some of these factors in specific geographic areas using different methodologies, the unique contribution of Sacurima was to develop and use a uniform method to measure these attributes among farm operators, family members and employees, based on well-tested conceptual models of health and safety behaviour. A validated quantified measure of safety culture can be used for benchmarking national performances and informing interventions to guide farmers to act in a safe and healthy way. Within the Sacurima COST Action network there is a wide understanding that the development of safety culture on farms increases the potential for more effective overall management and better safety practices.

Background

Agriculture is one of the most dangerous occupations. At least 170,000 agricultural workers are killed worldwide each year (ILO, 2015). Of the nearly 3,500 workplace fatalities that are recorded annually within the European Union, approximately 20–25% are related to agriculture (Eurostat, 2021). The non-fatal accident rate is approximately 1500 accidents per 100 000 workers (Merisalu et al., 2019). More detailed statistics for farm accidents in the EU are given in Information Box 1.



Figure 5. Machinery maintenance reduces the risk of accidents and property damage. Photo: Jarkko Leppälä.

Information Box:**Statistics for farm accidents in the EU**

- Agriculture has the worst fatal accident record of all major employment sectors
- Over 550 fatal accidents in the agricultural sector occur across the EU each year and many go unreported
- The stated fatal accident rate for the EU15 in 2,000 was 12.6 /100,000 workers
- The rate for non-fatal accidents with more than 3 days absence is more than 6,000/100,000 workers
- 30% of injuries in agriculture happen during machinery maintenance and repair
- The average compensation cost for farm machinery injuries is 3,796 € and the average lost work time is 32.6 days

Tractor accidents are the most common cause of machine-related injuries on farms. A third of the tractor injuries are the result of jumping, slipping or falling from the tractor

To tackle these accidents and injuries on farms, there are two basic approaches. One is to address the *consequences* of accidents through organising rapid emergency interventions to save lives and adequate follow-up to help the victims cope with the medical and psychological consequences of the injuries. The other is to address the *root causes* of the accidents, by identifying and acting on the behavioural and environmental determinants of health and safety problems through preventive interventions (Figure 5).

In general, there are two kinds of factors that can cause accidents (Figure 6): structural and behavioural ones (Gielen and Sleet, 2003). Structural factors are those that exist in the environment in which one works. They include the work environment, equipment and technology, the work processes and volumes, etc. Behavioural factors refer to unsafe practices performed by workers that can lead to an accident, such as unsafe handling of machines or animals, not wearing protective gear, or not adhering to safety guidelines. To improve the safety of farmers and reduce the incidence of accidents, both types of causes need to be addressed (Leppälä 2016; Reason 1997). While over the past decades risk management practices have made great progress in addressing the structural risks, by increasing the safety of equipment through engineering and improving the conditions of work through organizational or legal measures, unsafe behaviour remains a challenge, as the decision to perform a behaviour ultimately resides with the individual. Nevertheless, prevention science has demonstrated that unsafe behaviour can also be influenced. This can be achieved in three ways that are commonly described as the "3 E's" of health and safety: Engineering, Enforcement and Education.

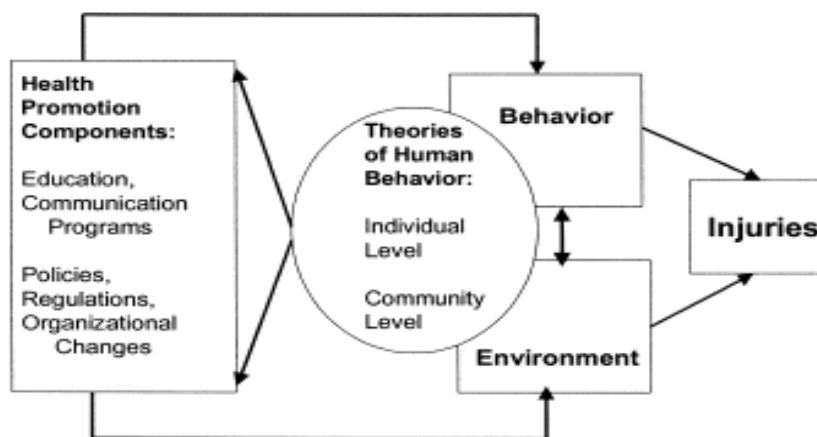


Figure 6. Structural and behavioural factors that cause accidents (Gielen & Sleet, 2003).

Of the three E's, education is the most widely applied strategy to change farmers' risk behaviour, and the most underestimated one. Systematic reviews (De Roo & Rautiainen, 2000; Burke & Ng, 2006; Coman et al., 2020) have shown that farm safety education programs can be effective in promoting safety-enhancing behaviour, but only if they meet certain quality conditions. One of these conditions is that they need to go beyond mere information giving and skills training and address the whole range of factors that influence farmers' decisions to behave in a way that is safer and avoids risks, such as attitudes, perceived norms, perceived competence, habits, or the safety culture of the farmers' community. These (mainly psychological) factors are elucidated in health behaviour models. Yet it turns out that only very few farm safety education programmes are based on such models (Colemont & Van den Broucke, 2006). This lack of theoretical grounding reduces the effectiveness of farm safety education.

To address this issue, the Sacurima COST network decided to develop a questionnaire to measure the determinants of farmers' safety behaviour as proposed in a state-of-the art conceptual model and apply this questionnaire in a uniform way in the participating countries, so as to obtain a mapping of the main factors that influence health and safety related behaviour of farmers. The results of this mapping can provide a basis for the development of more effective educational interventions promoting occupational health and safety among farmers.

Theoretical models of farmers' safety behaviour

Behavioural (or theories) have been developed to explain behaviours of people in specific situations. One of the most well-known and widely used of these models is the Theory of Planned Behaviour (TPB), developed by Ajzen (1991). As an example of the broader group of expectancy-value theories of psychology, the model has been proposed to explain intentional behaviour, i.e., behaviours which a person chooses to perform, based on a cognitive reflection process involving various beliefs. Specifically, the theory states that people's health and safety behaviour is based on their intention to perform that behaviour. This intention is in turn influenced by attitudes towards the behaviour (based on the expected outcomes and their subjective value), subjective norms (or the belief of what other people think about the behaviour or do themselves), and subjective control (or the subjective belief whether or not one is capable of performing the behaviour). The TPB has been widely used to explain various types of behaviours and found effective in explaining and predicting health related behaviours such as smoking, healthy eating, engaging in physical activity, or participating in health screening. A small number of studies have also applied the model to safety behaviour in agriculture (Colemont & Van den Broucke, 2006), leading to the

conclusion that the use of this model allows better predictions of intentions and/or of the safety behaviours of interest and thus can contribute to a better understanding of the determinants of health and safety related behaviour of farmers.

However, the TPB only considers individual determinants of safety behaviour, it does not take account of influences of the social and physical environment that can also influence safety behaviour. Some authors have therefore suggested extending the model by adding other variables such as habits, moral norms or contextualized knowledge (Rezaeia et al., 2018). Others have pointed to the importance of physical or social barriers that may impede the performance of safe behaviours, even when the person has the intention to act safely. In addition, safe behavior can be stimulated by “nudges” or “cues to action”, i.e., elements in the environment that may act as a stimulus to act on an intended behaviour.

Information Box:

Definitions of Safety Culture

“The way in which safety is managed in a workplace. It is the combination of beliefs, perceptions and attitudes of employees toward the safety of workers and the overall safety of the work environment. Cultivating a safety culture is a key aspect in maintaining workplace safety.”

“A positive safety culture is the culture of a workplace in which all the employees think of safety as an important thing and behave in a way that prioritizes their own safety as well as the safety of those around them. This includes using proper personal equipment, following the safety laws and just generally being conscious of safety and safe practices at all times.”

(Source: Safeopedia)



Photo: Risto Rautiainen.

An important potential contributor contributor to safety behaviour that is often neglected in efforts to prevent injuries in agriculture is *safety culture* (McNamara et al., 2018). As a quality of the social environment, safety culture refers to the way in which safety is managed in a workplace. It represents the combination of beliefs, perceptions and attitudes of employees toward safety and the overall safety of the work environment (Edwards et al., 2013), and is considered to include values, perceptions, competencies, and patterns of behaviour that are stable over time (Cox and Flin, 1998). Organisations with a positive safety culture are characterized by communications founded on mutual trust, shared perceptions of the importance of safety, and confidence in the efficacy of preventive measures. While the concept of safety culture is typically applied to well-structured and regulated working environments like industry or commercial companies and seems less obvious for smaller semi-independent entities like farms, as applied to farms it could refer to the behaviour, attitudes, norms and practices of the *community* of farmers, which can influence an individual farmer's safety behaviour. Having a good safety culture on a farm also brings about a more positive and attractive image, a better understanding of the value of farm work in food production, better farmer welfare, better farm business value, better farm management and better risk management (Figure 7).



Figure 7. Good safety culture is part of good farm management. Photo: Luke.

Measuring the determinants of farmers' safety behaviour

A first step towards enhancing safety behaviour among farmers is to identify the behaviours that are unsafe, as well as the factors that determine their safety behaviours and practices. To that effect, there is a need for empirical data (Coman et al., 2020; Colemont & Van Den Broucke, 2005; 2008), and this requires having an adequate tool to measure these concepts in a reliable and valid way. Working Group 2 of the COST Action of Safety Culture and Risk Management in Agriculture (Sacurima) took on this task and developed a uniform measure of safety behaviour and its determinants among farmers, based on a state-of-the-art integrated conceptual model of health and safety behaviour.

Specifically, the measure was a self-report questionnaire measuring farmers' safety practices with regard to four key risk behaviours which, according to international research (Rautiainen et al., 2010; Karttunen et al., 2015; Leppälä et al., 2013, 2016; Donham et al., 2016; Moradhaseli et al. 2020) are the main causes for accidents, injuries and health problems among farmers (i.e., falls prevention, machinery handling, handling chemicals and pesticides, and animal handling), and the socio-cognitive and contextual determinants underlying these practices. For the latter, use was made of an extended version of the Theory of Planned Behaviour, where in addition to constructs of attitudes (based on the expected outcomes and their subjective value), subjective norms (based on normative beliefs and motivation to comply) and subjective control (based on beliefs of one's own capacity to perform the behaviour) the dimensions of physical barriers, cues to action and safety culture were added (Figure 8).

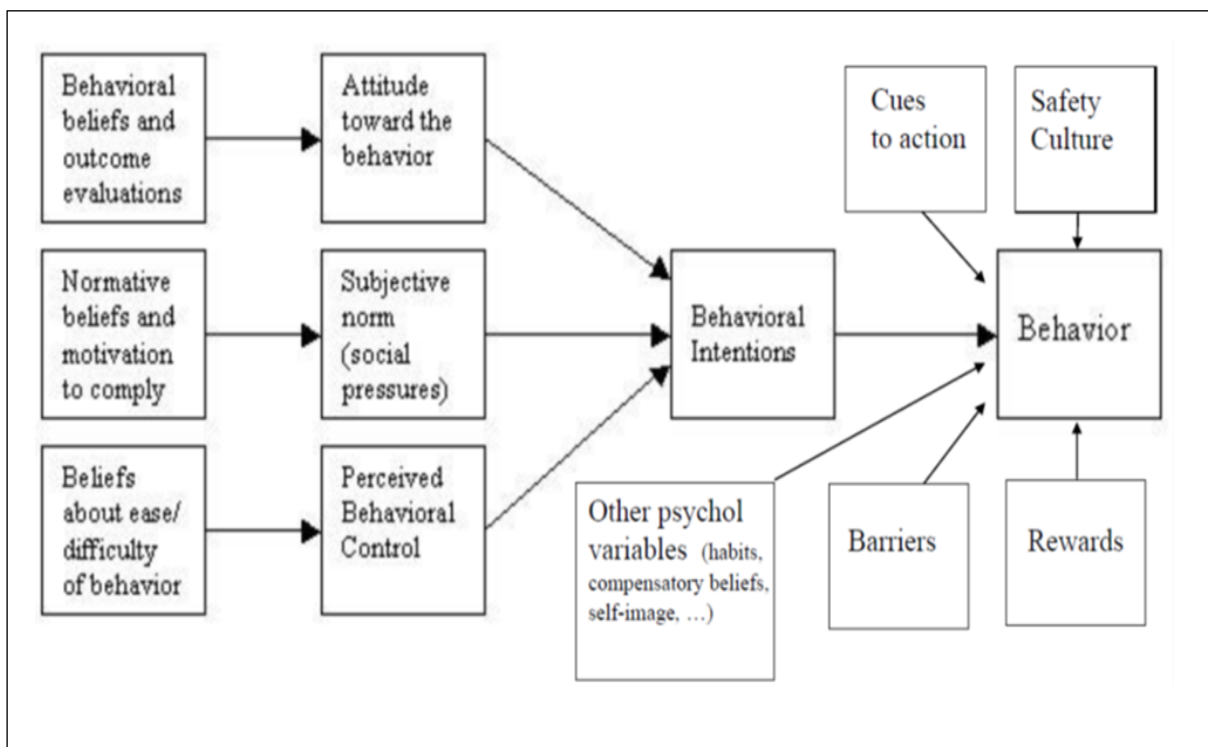


Figure 8. An extended model of determinants of farm safety behaviour.



Photo: Risto Rautiainen.

Preliminary study of farm safety behaviour and its determinants in 12 European countries

The survey instrument consisted of 81 questions, 8 of which measure demographic characteristics, 3 on the respondent's injury history, 17 on the farmer's safety practices with regard to the four key risk behaviours (fall prevention, machinery handling, handling chemicals and pesticides, and animal handling), 35 on the socio-cognitive determinants underlying these practices (expectancy based attitudes, perceived norms, perceived control, behavioural intentions), 5 on the perceived safety culture, and 7 on the importance of physical obstacles to safety practices. The questions regarding behaviour and their determinants had to be answered using Likert-type scales (1 = never, 5 = always for the behaviours, and 1 = strongly disagree, 5 = strongly agree for the socio-cognitive and safety culture items). For three of the four safety practices and their socio-cognitive determinants, the questions were preceded by a filter question (Do you work with machines/chemicals and pesticides/animals on your farm – yes/no), which allowed farmers for whom these questions are not relevant to skip parts of the questionnaire and thus save time.

The questionnaire was developed in English standard format and was translated into the national languages of the participating countries. This translation process involved three stages. First, a forward translation into the national language(s) was performed by the Sacurima member who was responsible for performing the survey. In a second stage, the translated version(s) was back-translated into English. In case of differences in translation, a consensus process decided on the most appropriate translation. In a third stage, a focus group was organised to check the comprehensibility of the translated version of the questions. In case of severe translation or comprehensibility problems, the WG2 leaders were contacted to help decide on any changes in wording of the questions considered necessary, to ensure comparability of the questions across countries.

The resulting questionnaire was applied in a pilot study involving participants from twelve countries: Belgium, Croatia, Finland, Germany, Greece, Ireland, North Macedonia, Portugal, Romania, Serbia, Sweden and Turkey. Data were collected and analysed during the years 2019 –2021. Participants were recruited by the Sacurima member using convenience sampling, and, following informed consent, were asked to complete the questionnaire in their own language. The data collection procedure varied between countries and could be either online survey (via an online survey software), on paper, by telephone, or face-to-face. In the case of telephone or face-to-face interviews, the interviewers underwent a training prior to starting the data collection.

In countries where national regulations foresee a review of ethical conduct requirement (e.g. through ethics committee within universities), it was ensured that these countries met the requirements. Where such requirements and ethics committees were not in place, national ethical guidelines concerning population surveys were followed and the protocol was submitted to a relevant board at national level. Furthermore, each country participating in the survey ensured compliance with the applicable national data protection legislation. EU-Member States additionally ensured compliance with the EU General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679, 2016). Furthermore, it was guaranteed that all participants were fully informed about the research and procedures in place to enable them to withdraw from the study if requested, were informed of the ways in which confidentiality and anonymity was assured and given details with regard to who can access the data and how it is stored and used. At the beginning of the survey, participants were informed that they could decide whether or not to participate and that they did not have to answer questions if they preferred not to. The actual data collection was preceded by a field test of the (translated version) survey questionnaire in each country on 5 participants, using purposeful sampling for the field-testing to ensure equal distribution of participants in terms of age, gender and region.

Results of the survey study*

A total of 1.642 valid questionnaires were returned. Table 1 gives the characteristics of the study participants, showing that the number of participants per country varied widely, between n=16 for Romania to n=599 for Finland. Roughly one third of the respondents (31%) were female. The majority (69%) were full-time farmers, the remaining third worked part-time as a farmer. Farm owners accounted for 77% of the respondents, the remaining 23% were farm workers. The most common farm production types in the sample were livestock production (34%), dairy production (32%), and commercial grain farming (29%), whereas commercial plantations (15%), subsistence farming (14%), pig or sheep farming (13%), and horticulture (8%) were less represented.

Table 1. Participants' characteristics and experience with accidents.

Country	Number of respondents	Gender % M/F	Full-time farmer %	Farm owner %	Employing others %	Personally involved in injury %	Others involved in injury %
Belgium	55	69/31	73	84	53	33	26
Croatia	202	57/43	63	32	10	16	19
Finland	599	59/41	81	91	22	47	35
Germany	107	88/19	77	85	39	29	42
Greece	36	89/11	58	81	58	42	19
Ireland	226	85/15	46	74	17	23	13
North Macedonia	47	77/23	53	79	49	34	17
Romania	16	63/37	75	63	44	13	0
Serbia	79	92/8	54	84	22	27	9
Sweden	26	62/38	54	73	54	35	31
Turkey	224	75/25	70	75	25	25	22
Portugal	27	89/11	63	85	74	4	30
Total	1,642	69/31	69	77	25	32	26

Involvement in farm accidents

A third of the participants (32.3%) declared having been personally involved in a farm accident causing an injury, and a quarter (25.9%) had seen others on their farm get involved in an accident, of which 11 had a fatal outcome (Table 1). Approximately 28% of the accidents caused more than four lost days in work. The incidence of farm accidents differed significantly between countries, with the highest percentages of personal involvement in farm accidents reported for Finland (47%) and Greece (42%), and the lowest for Portugal (4%), Romania (13%) and Croatia (16%). For witnessing others involved in an accident on the farm, the highest incidences were reported for Germany (42%) and Finland (35%), and the lowest for Romania (0%) and Serbia (9%).

Table 2. Accident rates by type of farming.

	<i>% accident</i>	<i>B</i>	<i>Wald</i>	<i>OR</i>	<i>p</i>
Personally involved in an accident with injury					
dairy farming	43.9%	0.616	28.529	1.852	<0.001
livestock	30.1%	-0.167	2.067	0.846	0.150
pigs or sheep farming	28.4%	-0.113	0.434	0.893	0.510
subsistence farming	31.8%	-0.167	0.808	0.860	0.369
commercial plantations	34.2%	0.176	1.226	1.192	0.268
horticulture	15.0%	-0.992	15.355	0.371	<0.001
commercial grain farming	25.3%	-0.380	53.285	0.488	<0.001
Others involved in an accident with injury					
dairy farming	39.3%	0.951	60.970	2.587	<0.001
livestock	25.1%	-0.030	0.058	0.970	0.810
pigs or sheep farming	31.3%	0.448	6.702	1.565	0.010
subsistence farming	21.5%	-0.542	7.729	0.582	0.005
commercial plantations	28.3%	0.277	2.650	1.319	0.104
horticulture	20.3%	-0.140	0.371	0.870	0.542
commercial grain farming	21.7%	-0.229	2.757	0.796	0.097

Table 2 shows the probability of being involved in an accident by the type of farming. As the table shows, the risk of being involved in an accident with injury is nearly twice as high for dairy farmers (OR=1.852, $p<0.001$) than for other types of farming, whereas farmers working in horticulture (OR=0.371, $p<0.001$) or commercial grain farming (OR=0.488, $p<0.001$) are less likely to be involved in an accident. The probability of others on the farm getting involved in an accident is also by far the highest for dairy farming (OR=2.587, $p<0.001$), followed by pigs or sheep farming (OR=1.565, $p<0.010$), and the lowest for subsistence farming (OR=0.582, $p<0.005$). Furthermore, for the whole sample, farm accidents leading to an injury are significantly more likely to happen to farmers who received training in agriculture (OR=1.369, $p<0.001$) and who employ others (OR=1.372, $p=0.023$), but less likely to those who are full time farmers (OR=0.518, $p<0.001$) (not in the Table). Age, gender, or farm ownership did not influence the probability of having an accident.

Safety behaviour

To measure the safety behaviours of the farmers who participated in the study, four scales were constructed from the 17 items measuring the farmer's safety practices regarding the four key risk behaviours, using reliability analyses (Cronbach's alpha statistic) to check internal consistency. After removing the items that reduced the internal consistency, fall prevention was measured with 4 items (Cronbach $\alpha = 0.74$), machinery handling with three items (Cronbach $\alpha = 0.53$), handling chemicals and pesticides with five items (Cronbach $\alpha = 0.72$), and animal handling with three items (Cronbach $\alpha = 0.370$). The latter scale needs to be interpreted with caution, given the low reliability.

The mean scores on the safety behaviour variables for each of the participating countries are presented in Table 3. It is noted that on average the scores are relatively high (all scores ≥ 3.37 on a 5-point scale), but there are differences between the countries. Belgium, Croatia, Germany, North Macedonia, Romania, Serbia and Turkey score higher than the overall average for fall prevention. For safe machines handling, North Macedonia, Portugal, Romania and Turkey score the highest, and for chemicals and pesticides handling Croatia, Germany, Ireland, North Macedonia, Portugal, Romania, and Serbia. Safe handling of animals gets comparatively higher scores in Belgium, Germany, Ireland, Portugal and Sweden. Across countries, safety measures in the handling of chemicals and pesticides and of animals are best adhered to, and in machines handling the least.



Photo: Risto Rautiainen.

Table 3. Mean scores on four farm safety behaviours per country.

Country	Fall prevention	Machine handling	Chemicals and pesticides handling	Animal handling
Belgium	4.07	3.67	3.93	4.30
Croatia	4.24	3.37	4.41	3.67
Finland	3.63	3.79	4.27	4.25
Germany	4.06	3.98	4.38	4.44
Greece	3.92	3.67	3.77	3.79
Ireland	3.90	3.76	4.31	4.57
North Macedonia	4.01	4.03	4.30	3.98
Portugal	3.92	4.37	4.62	4.42
Romania	4.39	4.14	4.93	4.04
Serbia	4.25	4.04	4.34	4.13
Sweden	3.70	3.54	4.09	4.32
Turkey	4.24	3.93	3.93	4.16
Total	3.93	3.80	4.23	4.23

Table 4 shows the contribution of the four safety behaviours to the prevention of farm accidents leading to an injury. For three of the four behaviours, a higher mean score is obtained by those respondents who were not involved in a personal accident, although the difference is not significant for machine handling. For animal handling, the scores for those who did or did not have an accident are similar. A forward discriminant function analysis including falls prevention, machine handling, chemicals and pesticides handling as predictor variables produced a significant discrimination between farmers who did or did not experience an occupational injury (Wilks' lambda=0.979, χ^2 (4)=14.544, $p=0.006$, $R^2=0.144$). The structure matrix showed falls prevention (0.847) and chemicals and pesticide handling (0.605) to be the two behaviours that contributed mostly to this discrimination.

Table 4. Contribution of safety behaviours to the occurrence of a farm injury.

	INJURY		NO INJURY		F	P	DISCRIMINANT FUNCTION
	M	SD	M	SD			
Fall prevention	3.78	0.727	3.99	0.722	30.174	<0.001	0.847
Machine handling	3.77	0.797	3.81	0.823	1.100	0.294	0.229
Chemicals and pesticides handling	4.13	0.804	4.27	0.690	8.836	0.003	0.605
Animal handling	4.25	0.664	4.22	0.715	0.526	0.468	-0.024

Similar results were found for the contribution of the behaviours for the prediction of other people on the farm's involvement in an accident, with again a significant discriminant function (Wilks' lambda=0.978, $\chi^2(4)=15.564$, $p=0.004$, $R^2=0.149$). The structure matrix showed fall prevention (0.951) to be the main predictor of an accident involving others on the farm, with machine handling (0.381) and chemicals and pesticides handling (0.248) as additional contributors. In contrast, a discriminant function analysis looking at the impact of the four safety behaviours on the seriousness of accidents produced no significant results.

Determinants of safety behaviour

To measure the socio-cognitive and contextual determinants of the four safety behaviours investigated in this study, a series of scales were constructed based on the responses on the 47 questions on socio-cognitive determinants, perceived safety culture, and physical obstacles to safety practices contained in the questionnaire. For the creation of these scales, exploratory principle component analyses with Varimax rotation were used to identify the underlying dimensions of each set of questions related to the farmers' perceptions and beliefs regarding each of the behaviours with the number of factors to be extracted fixed at 4), as well as for the sets of questions related to safety culture and physical obstacles (with the number of factors to be extracted based on the eigenvalue = 1 criterium). Items with a low factor loading were discarded. Cronbach's alpha statistic was used to check the internal consistency of the scales.

As a result, for fall prevention four scales were created (attitudes, perceived social norms, perceived control, and intention) each consisting of 2 items (explained total variance=78.95%); for machines handling three scales were created (attitudes, perceived social norm and intention) each consisting of 2 items (explaining 74.90% of the total variance), while perceived control was measured by a single item; for chemicals and pesticides handling four scales were created, two of which (attitudes and social norms) consisted of 3 items and two (perceived control and intention) of 2 items (explaining 66.13% of the common variance); and for animal handling three two-item scales were created (attitudes, perceived social norm and intention, explaining 76.90% of the total

variance), while perceived control was again measured by a single item. Safety culture was measured by a scale of 5 items explaining 54.54% of the variance (Cronbach $\alpha = 0.78$), and perceived obstacles by two scales, one measuring personal obstacles (tiredness, stress, unavailability, lack of time, workload) with 5 items, and one measuring external obstacles (financial constraints, weather) with 2 items.

These scales were used to test the models explaining each of the four safety behaviours. For each behaviour, two multiple regressions were performed: one testing the prediction of the intention to perform the behaviour on the basis of attitudes, perceived social norms and perceived behavioural control, as proposed by the Theory of Planned Behaviour, and one testing the behaviour on the basis of intention, perceived control, safety climate and personal and external obstacles, as proposed in the extended model (Figure 2). The results of the regression analyses are shown in Table 5.



Photo: Risto Rautiainen.

Table 5. The contribution of attitude, subjective norm, perceived behavioural, safety climate and perceived obstacles to perform safety related behaviours and intentions.

	R ² _{adjusted}	β	t	p
Fall prevention				
<i>Intention</i>	0.291			
Attitude		0.269	12.961	< 0.001
Subjective norm		0.263	11.667	< 0.001
Perceived behavioural control		0.184	8.316	< 0.001
<i>Behaviour</i>	0.173			
Intention		0.310	12.133	< 0.001
Safety climate		0.165	6.913	< 0.001
Personal obstacles		-0.112	-4.520	< 0.001
External obstacles		0.100	3.976	< 0.001
Perceived behavioural control		-0.021	-0.877	0.381
Machine handling				
<i>Intention</i>	0.428			
Attitude		0.585	26.584	< 0.001
Subjective norm		0.153	6.936	< 0.001
Perceived behavioural control		0.000	0.015	0.988
<i>Behaviour</i>	0.207			
Intention		0.388	15.114	< 0.001
Safety climate		0.142	5.565	< 0.001
Personal obstacles		0.049	1.770	0.077
External obstacles		-0.090	-3.242	0.001
Perceived behavioural control		0.095	3.694	0.381



Photo: Risto Rautiainen.

Table 5 (continued)

	$R^2_{adjusted}$	β	t	p
Chemicals and pesticides handling				
Intention	0.189			
Attitude		0.244	8.483	< 0.001
Subjective norm		0.153	5.415	< 0.001
Perceived behavioural control		0.197	7.010	< 0.001
Behaviour	0.202			
Intention		0.225	7.764	< 0.001
Safety climate		0.314	11.199	< 0.001
Personal obstacles		0.085	2.793	0.005
External obstacles		-0,012	-0.406	0.685
Perceived behavioural control		0.082	2815	0.005
Animal handling				
Intention	0.253			
Attitude		0.314	12,687	< 0.001
Subjective norm		0.238	8,833	<0.,001
Perceived behavioural control		0.134	4,932	< 0.001
Behaviour	0.130			
Intention		0.191	6.282	< 0.001
Safety climate		0.161	5.507	< 0.001
Personal obstacles		0.238	7,800	< 0.001
External obstacles		-0.267	-8.541	< 0.001
Perceived behavioural control		-0.070	-2.340	0,019

The results show that, as assumed by the TPB, the combination of attitude, subjective norm and perceived behavioural control contribute to the intention to perform safe behaviour. The model gives the best explanation for machine handling (adjusted $R^2=0.428$) and the least for chemicals and pesticide handling (adjusted $R^2=0.189$). For fall prevention, chemicals and pesticides handling and animal handling all three constructs of the model contribute significantly to the intention, whereas for machine handling, perceived control does not contribute significantly.

The results also show that behavioural intention, safety climate and perceived personal and external obstacles contribute to the performance of safe behaviour. This is the strongest for machine handling and chemicals and pesticides handling, where these factors account for 20% of the variance (adjusted $R^2=0.207$ and 0.202 , respectively), less so for animal handling (adjusted $R^2=0.130$). Of the contributing variables, intention and safety climate consistently are significant contributors to all four safety behaviours, whereas for fall prevention and machine handling perceived control does not contribute significantly to acting on the intentions to perform the actual behaviour; for

machine handling personal obstacles do not contribute significantly either, and for chemicals and pesticide handling, this is the case for external obstacles.

Summary and discussion

Working Group 2 of the COST Action Sacurima network aimed to identify the knowledge, attitudes, norms, competencies, and perceptions of farmers regarding safety, health and risk management, as a way to investigate the factors that determine their safety behaviours and practices. To achieve that objective, it was considered important to measure the determinants of safe or unsafe behaviour of farmers. Therefore, a survey questionnaire was developed based on empirically defined and widely used models of health-related behaviour as applied to farm safety, and a survey was held among farmers in twelve European countries.

A total of 1,642 farmers participated in the survey. The biggest sample was from Finland (599 respondents) and the smallest sample from Romania (n=16), so the variation between respondent numbers of the participant countries was high. Moreover, the selection of the participants was done through a convenience sampling method, and different methods were used to collect the data, namely via internet, phone or personal contact. As such, one should be careful not to compare the findings with regard to the incidence rates of farm accidents in the different countries. Nevertheless, it is important to note that approximately a third of the respondents had been personally involved in accidents on a farm causing an occupational injury, and that one out of four had seen other persons get injured on their farm. This underscores the fact that farming remains a dangerous profession, and that enhancing farm safety should be a priority.

One of the factors that lead to farm accidents is human behaviour. In the survey we focused on four specific behaviors that are often linked to (avoidance of) farm accidents: fall prevention, machine handling, chemicals and pesticides handling, and animal handling. Of these four behaviours, fall prevention, chemicals and pesticides handling and, to a lesser degree, machine handling were the most strongly related to farm accidents and injuries in our sample. The study also revealed that all these behaviours are to a significant extent determined by socio-cognitive factors such as attitudes, perceived social norms and perceived control, but also by factors in the social and physical environment, notably the safety culture within the farmers' community and perceived obstacles.

In conclusion, the results of the survey confirm the hypotheses that behavioural and nonbehavioural factors determine the behaviours of farmers that can lead to, or avoid, the occurrence of accidents on farms, and that these determinants can best be understood and explained by relying on well-evaluated theoretical models of human behaviour. As such, this pilot study offers guidance for improving safety training and education of farmers. Further research along the lines of this survey, involving more representative samples, could add to the understanding of what drives farmers to behaving safely, to further improve prevention efforts, and thus help reduce the unacceptably high level of farm injuries and fatalities in Europe.

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