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Watch Out for the Bull! Farmer Risk Perception and Decision-Making in Livestock Handling Scenarios

Ilinca Tone and Amy Irwin

Applied Psychology and Human Factors Group, School of Psychology, William Guild Building, University of Aberdeen, Aberdeen, AB24 3FX, UK

ABSTRACT

Livestock cause many fatal and non-fatal agricultural accidents. It is crucial to understand how farmers perceive and manage different risks associated with livestock handling to devise better solutions for accident reduction. The current study investigated farmers' perception and management of four types of livestock handling risks related to self, animal, environment, and equipment. Additionally, farmers' and agricultural stakeholders' perspectives were compared.

Two samples comprising 56 farmers and 55 stakeholders from the UK and Ireland completed the online study. Participants were presented with eight short livestock handling vignettes, two per risk type, and were asked to decide whether they would proceed with the task, to report their reasoning, and to detail their risk management strategies. Likert-scale responses across scenarios were compared. Thematic analysis was used to identify qualitative data patterns.

Stress and fatigue were perceived as low risk by both samples based on quantitative and qualitative results. The thematic analysis revealed that risk was evaluated in terms of broader aspects, including animal welfare and duty. Participants reported the use of cognitive non-technical skills when mitigating risks associated with handling livestock alone.

By changing safety messages to capture farmer priorities, agricultural organisations could encourage risk avoidance, especially in situations involving stress or fatigue. Furthermore, the cognitive non-technical skills identified could be trained within existing courses for farmers.

Introduction

Agriculture is the most dangerous industry in the United Kingdom and Ireland, with a fatality rate higher than any other sector.[1,2] Twice as many agricultural workers sustain non-fatal workplace injuries compared with the industry average.[3,4] Being injured by an animal has been consistently identified as a main cause of these injuries, accounting for approximately one in six fatalities and one in five non-fatal injuries.[4] Livestock handlers are involved in various tasks, including milking, feeding, moving, administering medication, and hoof trimming, which expose them to being kicked, crushed, stood on, or head butted. Dealing with certain classes of animals, such as bulls, increases the risk of injury further.[5] Livestock-inflicted injuries are generally more costly and result in more time off work than injuries by other causes.[6] Nevertheless, it has been suggested that few farm workers regard livestock as dangerous.[7]

Despite the prevalence and severity of agricultural injuries, there is limited research exploring farmers' own views of risk and safety.[8] Such a human factors approach focusing on farmer thought processes should be adopted given the likely involvement of human errors in agricultural accidents,[9] such as failures in attention and decision-making.[10] A risk orientation that places farmers in hazardous situations[11] and skills that can reduce error and subsequent injury[12] are psychosocial aspects yet to be explored in relation to livestock handling. It is crucial to understand how farmers perceive and manage risk to devise better solutions for injury and fatality reduction.

Risk perception

Risk perception is the subjective evaluation of the chances of an accident occurring and of its possible consequences, unlike the actual risk posed by

CONTACT Ilinca Tone i.tone.19@abdn.ac.uk University of Aberdeen, Applied Psychology and Human Factors Group, School of Psychology, William Guild Building, Aberdeen, AB24 3FX, UK.

a hazardous situation.[13] Whether a farmer perceives the level of risk as acceptable determines their future response. Risk taking occurs when the chosen behaviour can have negative or hazardous consequences. Although the literature has investigated objective hazards associated with livestock handling based on historical data,[6] only a handful of studies have explored farmers' subjective risk perception.[8]

Psychological and social theories of risk perception could be applicable to agriculture.[14] The mental models approach to risk perception posits that individuals interpret new information based on their current understanding of the world.[15] For example, farmers may have incorrect mental models derived from prior experiences; i.e. they may consider themselves safe as they have not yet experienced an accident handling livestock, and may thus continue to expose themselves to risks. Alternatively, theories of social reinforcers of risk-taking behaviour suggest that employees take risks due to factors in their physical and social work environment e.g. due to financial or time pressure.[16] Especially in routine activities such as milking where risk may be perceived as low, farmers may compromise safety and prioritize task completion.[17]

Some studies show that although farmers are aware of hazards, they still engage in unsafe behaviours,[18] due to environmental influences such as the constant presence of hazards or in response to industry challenges such as financial issues.[11] In a study investigating Swedish dairy farmers' perceptions of animal-related injuries, interviewees acknowledged that safety was sometimes not considered a priority, unlike cost or time saving.[8]

Nevertheless, the characteristics of risk could also impact its perception and management. An interview study with New Zealand farmers developed a model of quad-bike perception and management of risk.[19] According to the framework, farmers assess risk in relation to various factors, including the impact of previous incidents, familiarity with the equipment and the task, and duty to proceed. The level of risk could then either be accepted or rejected as too high. Should the farmers decide to proceed in tasks with anticipated risks, they would use their skills to prevent adverse events. The outcome of the risky situation would then feed into future risk evaluations. Arguably, this model encompasses elements of both risk perception theories outlined above.

In a recent study investigating British and Irish farmers' risk perception, participants were presented with scenarios depicting tractor-related risks and were asked to make "go/no-go" decisions on a five-point Likert-scale and to detail their reasoning.[20] Farmers were risk averse towards certain risks, such as illness, ditch erosion, fluid leak, and a missing power take off shield. In contrast, they balanced the consequences of personal risk with those of financial risk in scenarios related to equipment malfunction. Further research employing a similar method is required to explore risk perception and management in scenarios involving livestock handling, to develop a better understanding of how different risks are perceived and managed and to build specific interventions for key problem areas.

Non-technical skills

Non-technical skills (NTS) are the social (leadership, teamwork, communication) and cognitive skills (decision making, situation awareness, task management) required for safe and effective task performance.[21] Failures in NTS are strongly connected to adverse incidents in a variety of high-risk sectors.

Despite the large availability of literature on NTS in other high-risk industries, the resulting frameworks could not be directly extrapolated to farming, as these are context-specific.[22] Farming differs from other high-risk workplaces, as farmers work both alone and in teams, engage in activities with different associated risks,[23] and interact with cattle of various temperaments, which increases the risk of injuries.[8] An exploratory interview study with farmers from Scotland and Northern Ireland was the first to show that NTS are also necessary for safe and effective task performance in farming.[12] Interviewees reported that situation awareness, decision-making, and task management were relevant cognitive NTS for both team and lone workers, especially when mitigating risk.

The findings regarding the role of lone worker NTS are particularly informative, as there are many tasks that farmers conduct alone. Working alone is dangerous, as help is unavailable in case of accidents,[24] and it represents one of the main risk factors when handling cattle.[25] Thus, further research is needed to explore NTS use in lone livestock handlers specifically.

Different perspectives

Exploring safety from both the farmers' and agricultural stakeholders' perspectives can be informative in devising effective interventions,[14] especially as stakeholders and farmers may view risk differently.[11] Furthermore, such comparisons could reveal differences between work-as-imagined by stakeholders and work-as-done by farmers.[26]

Aims

There is a lack of research investigating farmer risk perception and NTS in relation to different categories of risk associated with livestock handling. It is crucial to understand how these hazards are perceived and managed to devise better solutions of injury and fatality reduction. Several categories of risk factors may influence the safety of animal handlers, including factors related to the self, such as fatigue and stress,[27] animal-related factors, such as familiarity and temperament, environmental factors, such as confined spaces or slippery floors, and equipment-related factors, such as an unsecured crush and no rump bar.[28] The overarching aim of the current study was to gain insight into farmers' risk perception and NTS associated with lone livestock handling across high-risk scenarios.

Methods

Participants

Farmers (N = 56) were recruited from the United Kingdom and Ireland in September-November 2018 (estimated response rate 10%). The recruitment criteria were farming as primary occupation and previous experience with cattle handling. Agricultural stakeholders (N = 55) were recruited from the same areas in February-May 2019 (estimated response rate 10%). The recruitment criterion was involvement in health and safety activities in agriculture. Farmers were contacted through UK- and Ireland-based online farming forums, via Twitter posts, and through emails sent to contacts in farming organisations who aided the recruitment process. Stakeholders were contacted via Twitter posts and through emails sent both directly and through organisations such as agricultural colleges or consultancy firms.

Data collection

Questionnaires were administered online through SNAP Survey Software. Participants completed an electronic consent form, followed by the questionnaire, with data collection occurring anonymously via SNAP.

Section 1. Farmers were asked to report their age, gender, training level, work environment when handling cattle, years of farming experience, work schedule, role, and size and type of current farm. Stakeholders were asked to report their age, gender, training level, farming experience, years of experience (where applicable), and their role and focus within their organisation (optional).

Section 2. The method used in this section was a "go/no-go" decision-making scenario approach previously utilized with tractor users.[20] Participants were presented with eight scenarios, each detailing a single risk factor related to cattle handling. The risk factors were from the following categories of hazard: compromised performance (fatigue and stress), animal-related factors (unfamiliar bull and angry bull), environmental hazards (slippery floor and no escape route), and faulty equipment (unsecured crush and no rump bar). These were drawn from potential issues identified in the literature[27] and Health and Safety Executive (HSE) guides.[28] Scenarios consisted of two sentences each and placed the risk factor in the context of a cattle handling task when working alone. For instance, the scenario featuring stress read: "*You are under a lot of stress as you have just found out that your farm is not making profit. As it is the summertime, you need to move the cattle on pasture in a few minutes.*"

All participants were asked to indicate if they would proceed in each scenario on a five-point Likert scale, ranging from *No, definitely not = 1* to *Yes, definitely = 5*. They were then asked to provide their reasoning and to describe any risk management strategies they would use. Stakeholders were asked to imagine they were acting as the farmers in each scenario.

Data analysis

Demographic information was used to describe each sample. A mean and frequency table was computed for both samples based on the Likert-scale responses to each scenario. A repeated-measures ANOVA was conducted for each sample to compare responses across scenarios. Independent-samples t-tests were conducted for each scenario to compare farmers' and stakeholders' responses.

The data obtained through open-ended questions were analysed using thematic analysis, a suitable method for vignette studies and the size of the current samples.[29] Data from farmers were analysed first. The process consisted of a familiarization stage in which initial thoughts were noted, followed by a coding stage in which data were categorized semantically, both stages being conducted iteratively by the first author as more data were being collected. The complete coding for the first three vignettes was checked for accuracy by the second author and a final list of codes was agreed upon. These were then evaluated to determine overarching themes. Finally, the proposed themes were reviewed by both authors and, where necessary, altered to ensure each was valid and represented a coherent pattern of data. Identical steps were involved in the thematic analysis of the data from stakeholders, except for the coding stage, in which data were semantically coded based on the final list of codes for farmers. New codes were generated only where existing codes were not applicable. The number of mentions for each code and theme was recorded for both samples.

Results

Participant characteristics

Demographic information for both samples is reported in Table 1.

Quantitative analysis

The pattern of mean and frequency of responses indicated variation across scenarios for farmers and stakeholders (Table 2). Both samples predominantly responded "go" for fatigue, stress, and slippery floor and "no-go" for unfamiliar bull, angry bull, no escape route, and unsecured crush. For no rump bar, farmers mostly responded "no-go" and stakeholders "go", respectively.

Repeated-measures ANOVAs (8 x scenario) revealed a significant effect of scenario on responses for farmers, $F(7, 315) = 27.66$, $P < .001$, and for stakeholders, $F(5.18, 258.92) = 51.00$, $P < .001$. Post-hoc tests using the Bonferroni correction for multiple comparisons for farmers and stakeholders (Table 3) indicate multiple differences between scenarios. For farmers, the pattern indicates the scenarios involving stress and fatigue were associated with a significantly higher mean score (i.e. a "go" response) than the scenarios involving an unfamiliar bull, an angry bull, no escape route, unsecured crush, and no rump bar, which were all associated with a significantly lower mean score (i.e. a "no-go" response). For stakeholders, the pattern indicates the scenarios involving stress and fatigue were associated with a significantly higher mean score than the remaining scenarios. The scenario involving an angry bull was associated with a significantly lower mean score than the remaining scenarios.

Independent-samples t-tests computed for responses to each scenario revealed a significant difference only for scenario 4, featuring an angry bull, between farmers (M: 2.24, SD: 1.26) and stakeholders (M: 1.57, SD: 0.90); $t(90.3) = 3.08$, $P < .005$ indicating farmers were more likely to go ahead in that scenario than stakeholders (though still risk averse in that scenario overall).

Table 1. Demographic characteristics for farmers and stakeholders (mean or frequency).

		Farmers		Stakeholders	
Demographic	Category	M (SD)	Frequency (%)	M (SD)	Frequency (%)
Gender	Male		37 (66)		29 (52.7)
	Female		17 (30.4)		25 (45.5)
	Not specified		2 (3.6)		1 (1.8)
Age		47.2 (12.6)		45.1 (11.4)	
Farming experience	Yes				47 (85.5)
	No				7 (12.7)
Years of experience		32 (13.9)		24.7 (11.9)	
Training level	On-farm training		14 (25)		2 (3.6)
	Certificate/diploma		18 (32.1)		13 (23.6)
	Undergraduate degree		21 (37.5)		20 (36.4)
	Postgraduate degree		2 (3.6)		19 (34.5)
	Other		1 (1.8)		
Handling cattle	Alone		14 (25)		
	As part of a team		8 (14.3)		
	Both		33 (58.9)		
Work schedule	Full-time		42 (75)		
	Part-time		14 (25)		
Role on farm	Farm owner		39 (69.6)		
	Farm manager		6 (10.7)		
	Farm worker		5 (8.9)		
	Temp worker		2 (3.6)		
	Other		4 (7.1)		
Farm size (acres)		619.3 (1025.5)			
Type of farm	Dairy		16 (28.6)		
	Mixed animal		16 (28.6)		
	Beef cattle		9 (16.1)		
	Mixed animal and crops		9 (16.1)		
	Sheep		4 (7.1)		
	Pigs		1 (1.8)		
	Arable crops		1 (1.8)		
Role in organisation	Agricultural officer				16 (29.1)
	Advisor/Consultant				7 (12.7)
	Education/Research				5 (9.1)
	Manager/Executive				5 (9.1)
	Inspector				4 (7.3)
	Farmer				2 (3.6)
	Other				3 (5.5)
	Not specified				13 (23.6)
Focus in organisation	Livestock				24 (43.6)
	Livestock and land				6 (10.9)
	Livestock and machinery				3 (5.5)
	Land				2 (3.6)
	Farm safety				2 (3.6)
	General				5 (9.1)
	Other				6 (10.9)
	Not specified				7 (12.7)

Qualitative analysis

The results of the thematic analysis for both samples are presented in Table 4 for risk perception and management and in Table 5 for NTS, with examples and frequencies per scenario provided for each code. The following sections describe risk perception and management per category of scenario and the use of NTS across scenarios.

Compromised performance

The primary reasons to proceed when fatigued or stressed were the prioritisation of animal welfare and the duty of completing the task, both more frequently mentioned by stakeholders than by farmers. In the fatigue scenario, exposure to risk was sometimes related to the unavailability of other staff members to carry out the required task.

Table 2. Frequency (%) and mean (SD) of scenario response for farmers (F) and stakeholders (S).

	Yes, definitely		Yes, probably		Not sure		No, probably not		No, definitely not		M (SD)	
Scenario	F	S	F	S	F	S	F	S	F	S	F	S
1.Fatigue	33 (58.9)	32 (58.2)	17 (30.4)	18 (32.7)	3 (5.4)	0 (0)	1 (1.8)	2 (3.6)	0 (0)	1 (1.8)	4.52 (0.69)	4.47 (0.85)
2.Stress	32 (57.1)	32 (58.2)	16 (28.6)	16 (29.1)	3 (5.4)	3 (5.5)	3 (5.4)	2 (3.6)	1 (1.8)	1 (1.8)	4.36 (0.95)	4.41 −0.9
3.Unfamiliar bull	6 (10.7)	7 (12.7)	7 (12.5)	10 (18.2)	4 (7.1)	9 (16.4)	7 (12.5)	11 (20)	29 (51.8)	17 (30.1)	2.13 (1.48)	2.61 (1.43)
4.Angry bull	3 (5.4)	1 (1.8)	7 (12.5)	1 (1.8)	8 (14.3)	6 (10.9)	14 (25)	12 (21.8)	19 (33.9)	34 (61.8)	2.24 (1.26)	1.57 (0.9)
5.No escape route	4 (7.1)	2 (3.6)	15 (26.8)	13 (23.6)	10 (17.9)	10 (18.2)	12 (21.4)	14 (25.5)	11 (19.6)	15 (27.3)	2.79 (1.29)	2.5 (1.24)
6.Slippery floor	18 (32.1)	12 (21.8)	15 (26.8)	19 (34.5)	8 (14.3)	7 (12.7)	6 (10.7)	13 (23.6)	4 (7.1)	1 (1.8)	3.73 (1.29)	3.54 (1.16)
7.Unsecured crush	7 (12.5)	6 (10.9)	10 (17.9)	8 (14.5)	7 (12.5)	5 (9.1)	11 (19.6)	15 (27.3)	17 (30.4)	19 (34.5)	2.6 (1.46)	2.38 (1.4)
8.No rump bar	9 (16.1)	6 (10.9)	14 (25)	21 (38.2)	3 (5.4)	7 (12.7)	16 (28.6)	13 (23.6)	13 (23.2)	7 (12.7)	2.82 (1.47)	3.11 (1.27)

Table 3. Mean difference in farmers' (F) and stakeholders' (S) response to scenarios based on pairwise comparisons using the Bonferroni correction.

	1		2		3		4		5		6		7	
	F	S	F	S	F	S	F	S	F	S	F	S	F	S
1	-	-												
2	0.28	0.12	-	-										
3	2.35*	1.9*	2.07*	1.78*	-	-								
4	2.26*	2.96*	1.98*	2.84*	−0.09	1.06*	-	-						
5	1.74*	2.06*	1.46*	1.94*	−0.61	0.16	−0.52	−0.9*	-	-				
6	0 .8*	0.98*	0.52	0.86*	−1.54*	−0.92*	−1.46*	−1.98*	−0.94*	−1.08*	-	-		
7	2.04*	2.2*	1.76*	2.08*	−0.3	0.29	−0.22	−0.77*	0.3	0.14	1.24*	1.22*	-	-
8	1.76*	1.41*	1.48*	1.29*	−0.59	−0.49	−0.5	−1.55*	0.02	−0.65*	0.96*	0.43	−0.28	−0.78*

*$P < .05$

Table 4. Thematic table with frequency (number of mentions) for risk perception and management across scenarios. F – Farmers, S – Stakeholders, S# – Scenario #.

		S1		S2		S3		S4		S5		S6		S7		S8	
Risk perception		F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S
Perception of risk level	**Risk is too high** *"I would not – too risky."*			1		22	11	28	42	13	19	8	6	24	29	13	12
	Risk is low *"No great risk."*	6	2	6	3			5	3	1	1	6	4	7	1	9	5
	Considering hazards and factors *"I would assess all risk."*	1	2	7	10	2	15	5	9	12	21		1	12	10	4	6
Animal-related factors	**Animal welfare** *"Animal welfare comes first."*	23	34	13	24	4	12	1	10	3	10	11	18	3	4	1	7
	Animal needs are paramount *"The needs of the animals override the needs of the carer."*	3	5	4	7												2
	Decision depends on animal type *"Would depend on [. . .] type of animal, age, size."*	1		3	1		1		1	11	9			1	2	7	3
	Dairy bulls are dangerous *"They can be more temperamental than other cattle."*					10	10										
	Fear of the unknown *"I don't know the bull and it does not know me."*					13	26							1			
	Concern about animal reaction *"The bull can become aroused and dangerous."*					7	6	7	22					6	9	5	8
	Knowledge of own livestock *"Perfectly happy to deal with my own stock."*	1				1	6		1	9	7			2	2		1
	Animals can decide on their own *"If he willingly wants to, he should be alright."*			1				5				1	1				
Resource-related factors	**Financial aspects** *"The farm will lose money."*	3	10	7	11				1			1		1	2		1
	Duty to complete task *"Has to be done."*	14	19	10	15	4	5			3	2	6	6	1	6	2	8
	Unavailability of staff *"Lone workers do not have a choice."*	20	18														
	Working alone is dangerous *"Never try to do this on your own."*			2		6	3	2		1						4	6
Perception of fatigue and stress	**Concern about fatigue** *"Fatigue can impact decision-making."*	10	9														
	Stress is always there *"Always under stress, you get used to it after a while."*			6	4												
	Stress is not an issue *"It wouldn't affect performance of this task."*			2													
Specific risks	**Biosecurity risk** *"Massive disease risk."*		3			3		1	1	1	1	1	4				
	Risk of injury *"Crush could move or topple leading to serious injury."*	1	1		1		1	3	4	2	4	4	4	3	9	4	5
	Risk of damage *"Danger to other cows, staff and the actual parlour."*							3	5								
Practical factors	**Decision depends on the set up** *"It would depend on set up."*	2		6	2			2		1	1						
	The importance of routine *"Routine and timings are essential."*	6	12	8	4	1		4				1	3	1		1	1
	New design features *"If the crush were of an appropriate size and weight."*								3					12	8		
	Task is too difficult *"It would be impossible to restrain the cattle."*															7	5

Table 4. Thematic table with frequency (number of mentions) for risk perception and management across scenarios (cont.).

		S1		S2		S3		S4		S5		S6		S7		S8	
Risk management		F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S
Managing compromised performance	**Sleep and rest** *"I can rest after milking is done."*	13	1														
	Use of stimulants *"I would take a strong cup of coffee."*	11	12														
	Music or radio *"Music to help keep awake."*		5														
	Work as stress relief *"Often working with animals can make you feel better."*			11	5												
	Mood matters *"Not handle cattle in an extreme stress."*	1	4	10	15	1											
	Time out when necessary *"I would step back for a few minutes."*			2	4												
	Separating the issues *"Address each issue independently."*			10	12												
Miscellaneous strategies	**Adherence to routines** *"I'd also ensure that I kept the routine."*	9	7	9	6			2		2		3		1		1	
	Proceed with common sense *"Common sense"*	5	5	5	5	1	1	2		2		2		2		2	
Animal-related strategies	**Avoiding animal stress** *"Keep noise and movement to a minimum."*	2	3	2	6		1	8	9	4	4	4	5	3	2	1	4
	Animal needs to be isolated/restrained *"Move bull to another pen"*				3	39	46	9	12	13	22			2	5	15	27
	Using food as bait *"Use feed for the bull as a distraction."*					3	3		3	2	5						
Equipment or environment-related strategies	**Management of environment** *"Try to run bull straight through parlour."*			2	6	2		7	2	1		10	17			21	31
	Use of sticks *"Stick to hand."*			3			1	2		6	5						
	Facilities matter *"Pen should be designed so that bull can be shut into separate compartment."*	1				14	22	5	5	8	8	7	4	11	8	7	2
	Escape route or refuge *"Always plan escape."*					8	12	5	4	12	18			1	2		
	Avoiding the danger zone *"Not enter collection yard until bull passes through."*			1			1	5	6	2	2		1	3	2	3	
	Clean it up! *"Clean down the area."*											34	46				
	Adjusting gait and using appropriate footwear *"Use suitable footwear and walk carefully."*											5	14				
	Secure or fix the crush *"I would secure the crush before continuing."*													11	28	5	11

Table 5. Thematic table with frequency (number of mentions) for non-technical skills across scenarios. F – Farmers, S – Stakeholders, S# – Scenario #.

		S1		S2		S3		S4		S5		S6		S7		S8	
Non-technical skills		F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S
Task management	**Planning and preparation** *"A task list to work through."*	5	4	4	13	5	5	2	2	6	6	8	7	5	4	3	1
	Prioritisation *"Do the minimum required [. . .] and delay the non-essential tasks."*	37	35	8	17	3	2		3	4	7	29	43	2	3	3	6
	Maintaining standards *"Make sure the head yoke was in good working order."*	4	5	2	3	1	3		3			1		3	2	4	
Situation awareness	**Maintaining awareness & exercising care** *"Aware of my surroundings"*	10	8	2	4	3	9	2	4	5	3	2	13	4	5	2	2
	Reading and predicting animal behaviour *"Bull seems to be in low mood, so this may be a dangerous strategy."*		1	1	2	1	7	19	22	7	16			3	1	2	2
Decision making	**Considering options** *"Either others to observe and assist or the bull would be moved."*	7	19		5	9	14	9	7	5	5	4	12	3	5	4	5
	Reflecting on consequences *"Putting stock outside to pasture would reduce cost."*	8	10	10	12	1	5	8	18	2	4	5	13	6	17	2	6
Communication and teamwork	**Bringing in help** *"Have another person present in case something went wrong."*	6	17	8	19	15	10	4	2	7	19			3	8	6	9
	Keeping in touch *"I'd ensure someone knew what I was doing."*	2	6	3	3	5	3	2	1	4	8	1	1	1	1	1	1

Whilst several respondents expressed concern about the adverse effects of fatigue on cognitive elements such as decision-making, stress was seen by some as always present and consequently less serious. This perception of risk was also reflected in the risk management strategies suggested. Many respondents recommended subsequent rest or the use of stimulants to manage their fatigue. Another strategy proposed by several stakeholders only was the use of music or radio programmes to keep oneself alert. Conversely, many farmers and several stakeholders considered the completion of the task a stress relief strategy in itself because of the positive impact of working outside with animals.0

Animal-related risks

Many participants explicitly stated the risk level was too high to proceed in scenarios involving animal-related risks. This was more frequently mentioned by farmers for an unfamiliar bull and by stakeholders for an angry bull, respectively, reflecting patterns in quantitative "go/no-go" decisions. In the scenario featuring an unfamiliar bull, the main concern was a fear of the unknown for both the handler and the bull. The dairy bull was also identified as a secondary hazard, due to temperament issues of the breed. Many participants expressed concern about the animal's potentially negative reaction, predominantly in the scenario featuring an angry bull.

Whilst animal welfare prompted a "go" decision in the scenario featuring an unfamiliar bull, the same factor was provided by many stakeholders as a reason to not proceed in the scenario featuring an angry bull, due to potential risks of injury to both animal and handlers. The main risk management strategy suggested was isolating or restraining the animal, and the importance of having appropriate handling facilities for the safe and effective completion of this task was acknowledged by many participants, especially in the first scenario.

Environmental risks

Whilst animal welfare was a reason to proceed in the scenario featuring no escape route, it represented an ambivalent factor in the scenario that featured a slippery floor. Thus, whilst several participants considered that milking would minimise animal discomfort, others decided against it on a slippery surface due to injury risks and stated the area needed to be cleaned. The improvisation of escape routes or refuges, as well as restraining the animals, was suggested by many respondents, predominantly stakeholders, as an appropriate risk mitigation strategy in the former scenario.

Faulty equipment

Many participants explicitly stated that the risk level was too high to proceed in the scenario

featuring an unsecured crush. Other respondents considered design features which could improve the stability of the equipment, such as the size and weight of the crush. The most common risk management strategy in this scenario was securing the crush, more frequently mentioned by stakeholders. Conversely, in the scenario featuring a crush with no rump bar, the preferred strategy was managing the environment to minimise animal movement, by using a halter, for instance.

Non-technical skills (NTS)

Task management

The importance of planning and preparation in the prevention of high-risk situations and effective task completion was widely acknowledged. Representative behaviours included the use of checklists or the preparation of tools. Several farmers demonstrated the use of prioritisation skills across scenarios, for instance by scheduling tasks appropriately and postponing jobs when necessary until safe to proceed. Many respondents established their priorities before proceeding with the task in scenarios involving compromised performance or a slippery floor. Several participants highlighted the importance of maintaining standards, such as checking the state of the equipment before proceeding.

Situation awareness

Several respondents emphasized the importance of monitoring their surroundings and the location of farm animals. Many also recommended increased vigilance and alertness to react promptly to changing circumstances when handling livestock. Furthermore, many participants stated that they would check for any signs of animal aggression or distress, which would feed into their prediction of future situations.

Decision making

Most respondents considered their options carefully and reflected on the potential consequences of their actions, demonstrating behaviours associated with decision making.

Social NTS

Many participants suggested bringing in help to compensate for staff shortages and for potential negative consequences of working alone. Some also highlighted the importance of keeping in touch when working alone or remotely, by updating others on location, task, and personal status.

Discussion

The results of the current study suggest that farmers were not risk takers when confronted with all categories of risk associated with livestock handling, despite the literature indicating a risk propensity related to personal safety.[11] Farmers were generally reluctant to proceed in scenarios featuring an unfamiliar bull, an angry bull, no escape route, an unsecured crush, and no rump bar, respectively, suggesting that these situations were regarded as potentially dangerous. Conversely, most farmers decided to proceed in scenarios featuring fatigue and stress. This indicates that risk perception is influenced by the characteristics of the risk presented.[20] Other factors unrelated to safety, such as animal welfare and the duty to complete the task, were considered alongside the hazard itself. The findings indicate an overall correspondence between farmers' and agricultural stakeholders' risk perception, which suggests consensus between work-as-imagined and work-as-done.[26] Farmers also reported the use of cognitive NTS when managing risks associated with handling livestock alone.

Limitations

The vignettes used placed the risk factor in the context of a livestock handling task to increase realism. Nevertheless, many respondents focused on both the risk factor and the task itself. Furthermore, livestock handling tasks varied across scenarios, e.g. milking, moving, hoof trimming, potentially interacting with the risk factor, and thus influencing responses. Future studies could present all risk factors in the context of similar tasks for better vignette equivalence. Nevertheless, this change is subject to practical constraints, as different risk factors are inherently

related to specific contexts, e.g. missing rump bar when using a crush. Notably, the "vignette world" is not an exact reflection of the "real world".[30] Vignettes were used in the current study to gain insight into farmers' risk perception in livestock handling situations rather than to examine real-life responses. To improve the realism of vignettes, expert advice would be desirable in further research.[31]

Risk perception

Participants displayed variability in their reported risk assessment across scenarios, which suggests the different risk factors described influenced the decision to proceed. Fatigue and stress have been shown to negatively impact situation awareness in other high-risk industries[32] and to cause agricultural accidents.[33] However, most farmers and stakeholders in the current study indicated they would proceed in scenarios featuring these factors. Stress was regarded as normal by some respondents, perhaps due to its chronic nature among farmers, perpetuated by issues with finance or policy.[18] Furthermore, several participants viewed work as stress relief, which also explained the decision to proceed with the task. The perception of stress and fatigue as low risk in contrast with other categories of hazards suggests a normalisation of these factors in agriculture, perhaps due to incorrect mental models derived from prior experience.[15]

In contrast with a similar study employing tractor-related scenarios,[20] the vignettes used in the current study involved livestock handling tasks, such as milking, moving, or feeding. Consequently, farmers took into consideration the welfare of their livestock when deciding across scenarios. This factor was generally considered a reason to proceed with the task. Conversely, in scenarios featuring an angry bull or a slippery floor, some participants highlighted the risk of injury to their livestock and decided not to proceed. Another factor that was consistently considered was the duty to complete the task, sometimes due to resource-related factors such as financial issues or unavailability of staff, which have been previously identified as representative characteristics of the farming environment.[11] These findings suggest that risk was assessed in broader terms than just personal safety, supporting theories of social reinforcers of risk-taking behaviour[16] and models featuring an analysis of risk in relation to various factors such as duty.[19]

Lone worker NTS

The current results suggest that situation awareness, with its three levels, perception, understanding, and anticipation,[34] is an important cognitive NTS for livestock handlers who are working alone, mirroring the findings of previous studies.[12] Farmers highlighted the importance of monitoring livestock and their surroundings and of reading and predicting animal behaviour, especially for angry or unfamiliar bulls.

Elements of task management, another cognitive NTS previously identified as useful in farming,[12] were also reported as important for livestock handlers who are working alone. Planning was regarded as crucial in the prevention of high-risk situations and in the organisation of work, a view that corroborates with HSE recommendations on the importance of problem solving and preparation.[35]

As each vignette was followed by a decision-making task, many participants generated options and reflected on potential consequences, which represent elements of decision-making.[21] This cognitive NTS has been previously identified as crucial in other high-risk industries, including healthcare[36] and aviation,[37] and more recently in farming.[12] Many respondents considered bringing in additional staff and keeping in touch when working alone or remotely, mirroring previous findings.[12] This suggests awareness of the dangers associated with lone work, including lack of help and risk of accidents.[24] These strategies may already be used by farmers to mitigate risk[19] but could be further trained through crew resource management (CRM)-type sessions based on similar approaches in aviation[38] and healthcare,[39] informed by real accident accounts from agriculture.

Conclusion

The outlined results suggest that farmers consider broader aspects when evaluating risk in livestock handling scenarios, including animal welfare and duty. By changing safety messages to capture farmer priorities, agricultural organisations could encourage risk avoidance, especially in situations involving stress or fatigue. Furthermore, the cognitive NTS identified in the current study could be trained within existing courses for farmers.

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ORCID

Amy Irwin http://orcid.org/0000-0003-2526-4750

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