Supplementary materials

Section A

The survey used to build the relation between injury risk and field operation survey questionnaire. The survey was built in SurveyXact software. Numerical values were allowed for estimating the frequency and duration of operations while categorical input was the only option for estimating the likelihood of incidents and likelihood of the different injury types (table 1 and 2).

With what type of production you are familiar?

(1) ❑ Pig

(2) ❑ Dairy Cattle

(3) ❑ Both

On the following pages, you will be asked to quantify the **frequency** with which an operation is performed (number of days per year), **duration** of the operation on the days when it is performed (in number of hours per day) and the **likelihood** of an injury hazard occurring when each time the operation takes place.

Questions are divided into:

- General farm maintenance and repair
- Dairy cattle farms
- Pig farms

Frequency and duration: general maintenance and repair

	Frequency (days per year)	Duration (hours per day)
Machine maintenance and repair	_____	_____
Building maintenance and repair	_____	_____

Hazard from machine maintenance and repair

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Hazard from building maintenance and repairs

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Dairy cattle farms

Frequency and duration of cattle operations

	Frequency (days per year)	Duration (hours per day)
Feed production	_____	_____
Moving cattle: indoors	_____	_____

	Frequency (days per year)	Duration (hours per day)
Moving cattle outdoors	_____	_____
Feeding	_____	_____
Milking	_____	_____
Manure management	_____	_____

Crop and feed production: cattle

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Moving cattle in housing

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Moving cattle outdoors

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Feeding cattle

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Milking

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Manure management for cattle

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Pig farms

Frequency and duration of pig operations

	Frequency (days per year)	Duration (hours per day)
Feed production	_____	_____
Moving pig Indoor	_____	_____
Feeding	_____	_____
Manure management	_____	_____

Crop and feed production for pigs

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Moving pigs

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Feeding pigs

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Manure management for pigs

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Crushing	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Cutting	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Falling	(1) ❑	(2) ❑	(3) ❑	(4) ❑

	Likelihood			
	Low	**Medium**	**High**	**Irrelevant**
Burning (fire, chemical, electric, scalding)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Poisoning (solid/liquid/gas)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Asphyxiating gas	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Drowning	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Suffocating	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Thanks for your contribution.

The numeric equivalent for the categorical values used to estimate the likelihood of potentially dangerous incidents and the frequency of serious injuries per number of incidents in the first survey were given as below in Tables 1 and 2.

Table S1: Numerical categories for the likelihood of the potential dangerous incident categories

Category	**Numerical equivalent (events/year)**
Low	Once per 5 years
Medium	Once per year
High	Three times per year
Irrelevant	Irrelevant

Table 2: Numerical categorires for the frequency of serious injury per incident categories

Category	**Numerical equivalent (number/event)**
Very low	1 in 10000
Low	1 in 1000
Medium	1 in 100
High	1 in 10

Section B

Below is the survey used to identify the reduction in risk of injuries under existing and future agricultural technological developments in cattle farms.

To what extent do you think that current technologies can reduce the risk of injuries for each of the following operations on dairy farms

Existing technologies: machine maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Building maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Crop and feed production

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Movement of animals (indoor)

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Treatment of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Movement of animals (outdoors)

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Feeding

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Milking

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Manure management

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

To what extent do you think future technologies can reduce the risk of injuries for each of the following operation on dairy farms

Future technologies: machine maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Building maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Crop and feed production

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Movement of animals (indoor)

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Treatment of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Movement of animals (outdoors)

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Feeding

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Milking

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Manure management

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

The survey used to identify the reduction in risk of injuries under existing and future agricultural technological developments in pig farms

To what extent do you think that current technologies can reduce the risk of injuries for each of the following operations on pig farms

Existing technologies: machine maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Building maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Crop and feed production

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Movement of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Treatment of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Feeding

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Existing technologies: Manure management

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

To what extent do you think future technologies can reduce the risk of injuries for each of the following operation on pig farms

Future technologies: machine maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Building maintenance and repair:

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Crop and feed production

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Movement of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Treatment of animals

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Feeding

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Future technologies: Manure management

	Reduction potential				
	None	**Low**	**Medium**	**High**	**Complete**
Frequency of operation (days per year)	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Duration of operation	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

Risk of potentially serious incidents	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑
Risk of serious injury per incident	(1) ❑	(2) ❑	(4) ❑	(3) ❑	(5) ❑

The numeric equivalent for the categorical values used to estimate the reduction potential of the different parameters in the second survey were given as below in Table 3.

Table S3: The numerical equivalent for the categorical values for the second survey

Category	**Numerical equivalent**
None	0
Low	0-33%
Medium	34-67%
High	68-99%
Complete	100%

Discussion among experts

After completing the survey, the experts were divided into two groups on their area of expertise and asked to discuss the following questions

- Which existing technologies can contribute the most to reducing accidents? If they are not being used to their full potential, why not?
- Which new technologies could contribute the most to reducing accidents?
- What are the biggest risks with the new technologies?
- Agree on 3-5 recommendations to reduce agricultural injuries.

The group questions aimed at providing a platform for experts to elaborate on their estimates and to capture information that was not captured in the quantitative questionnaire.

Results from the discussion among experts

The experts discussed a wide range of existing safety measures, including gas alarms and automated systems for cleaning and disinfection. . According to the experts, there are several technological options that can help in reducing potential incidents during the different operation activities. Hydrogen sulphide gas alarms in slurry housing, GPS, safety equipment during housing cleaning. Closed and automatic chemical systems (during cleaning and disinfection of slurry housing) led to a safer handling of dangerous chemicals and reduced chemical injuries. The cost of gas alarms is often high that farmers cannot afford, farmer's age (older farmers seems to be more resistant to new ideas), ignorance as some of the new employees coming from other cultures where the same level of safety is not practiced and the lack of interaction between farmers and manufactures are among the reasons why the existing technologies are not fully implemented. An example for the latter, there are several incidents that take place because of the electrified doors, also the falling accidents that occur when taking off the covers from silage stores. There is too little consideration for safety in new construction. Potentially dangerous incidents often arise in robot milking parlors when young cattle need to be introduced to robot milking. Although, experience exist for training milking robot, where there is no stress and the safety of animals and humans are in focus, these systems are currently not used extensively.

There is a high potential for future technological advancement; a) automatic gates that prevent sows from backing up when moving a large number of sows, b) smart methods to couple machines (some machines take their power from a tractor, so have to be coupled to it before they can be used), c) equipment to assist the movement of dead

animals, d) using, bracelets and behavior sensor for mapping danger when directly interacting with animals. However, some of these technologies may introduce other hazards, for example; lack of adequate instruction of new workers (on how to manage potentially dangerous situations), new technologies are complicated and constructed in an illogical manner (seen from the farmer's or worker's viewpoint) that will lead to safety systems being deactivated by the farmer or worker. Therefore, it is highly recommended to include safety instructions in the educational materials in agricultural schools and providing virtual reality and safety training especially in situations with direct interactions with animals.

Experts recommended a range of approaches to reduce injuries and enhance safety. Some of these measures are managerial that need to be implemented by the farmers, for example, sending workers on safety courses. However, the majority of the measures are expected to be delivered and implemented by decision makers. Making the publically available statistics more useable, introducing farm-tracking systems that allow a better access to the registration of near-by accidents, more guidance from the Working Environment Agency on workplace safety assessments that allows farmer's safety self-evaluation and including safety as a factor in the Danish Crown's certification system. The farm unions are expected to contribute in enhancing the safety through awarding an annual prize to the farmer/worker who contributes most to improving farm safety, publish a monthly idea for improving farm safety, appoint a named person on each farm who is responsible for safety monitoring and compliance, highlight accidents and problems e.g. in collaboration with insurance companies.

Section C

Raw data

There is an evident high variability in the expert's abstract estimates (Figures 1 and 2). The duration of operations ranged between 100- 5200 hours per year on typical pig and dairy cattle farms (Figure 1). The distribution of time on the different operations are varied with duration of individual operations ranging between 1 to 2160 hours on cattle farms and 15 minutes to 2555 hours on pig farms. The frequency of potentially dangerous incidents largely varies between operations for both production systems (Figure 2).

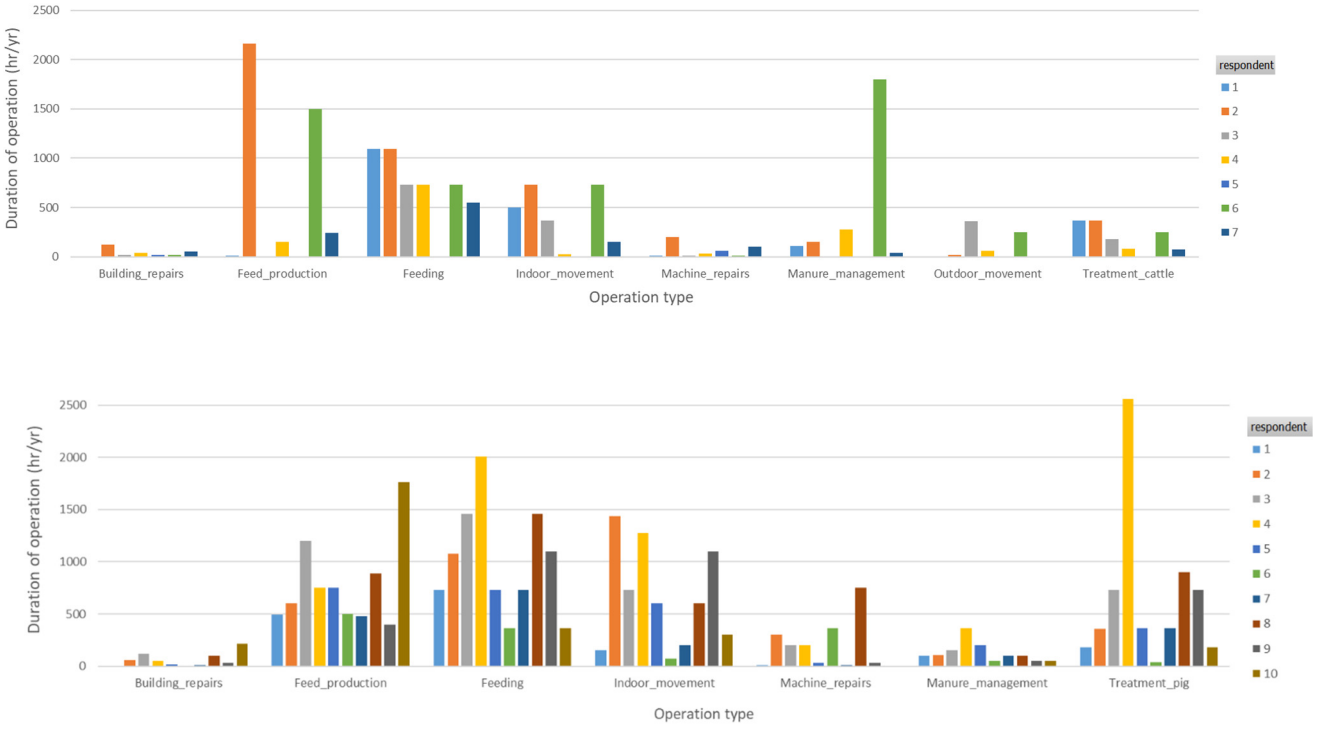

Figure S1: Numerical estimates for the duration of operations as estimated by experts on cattle (top) and pig (bottom) farms.

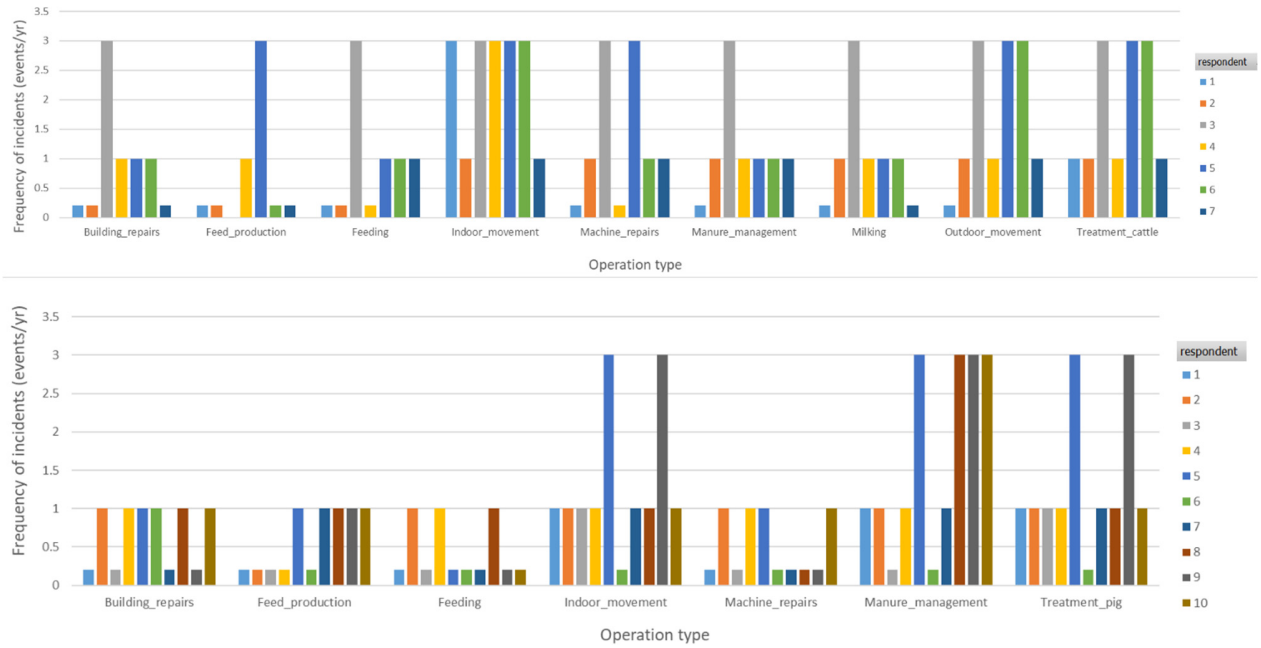

Figure S2: Frequency of potentially dangerous incidents on cattle (top) and pig (bottom) farms.

Section D

Estimation of the reduction in injuries

Existing technology

Using the available range of safety measures, a similar reduction in the frequency (number of times an operation needs to be performed) for all operations on both production systems. Milking and feeding operations on dairy cattle farms and building repairs and indoor movement on pig farms are the operations with a slightly higher reduction in frequency (Figure 3). Similarly, a comparable pattern was clear in the estimates of the reduction in duration of operations on dairy and pig farms (Figure 4). Experts considered 10% reduction in the frequency of incidents during all operations on dairy cattle farms will result from using the available technology. For pig farms, experts estimated that manure management and treatment of pig will have marginally higher reduction in the frequency of incidents compared to the rest of operations (Figure 5).

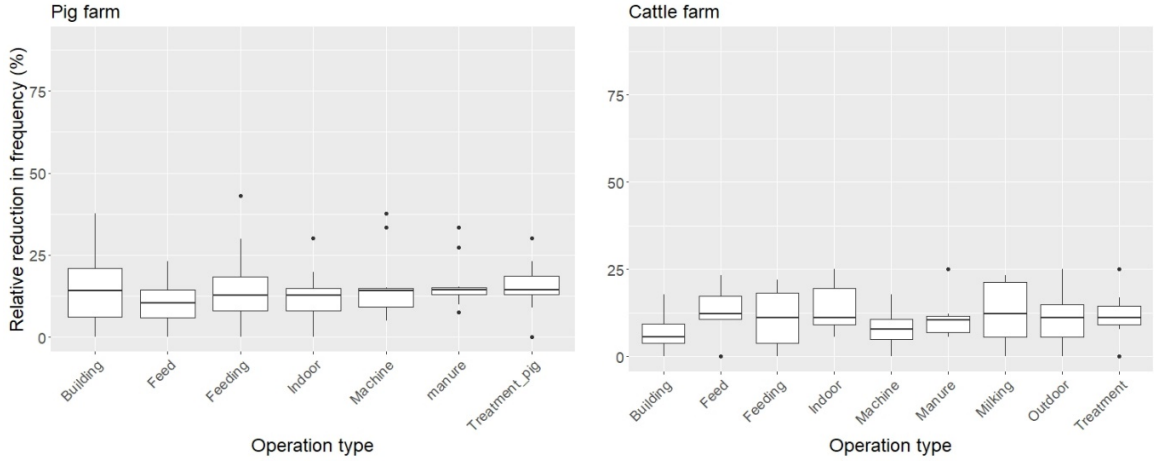

Figure S3: Estimated relative reduction in the frequency of operations through the use of existing technologies on both farms.

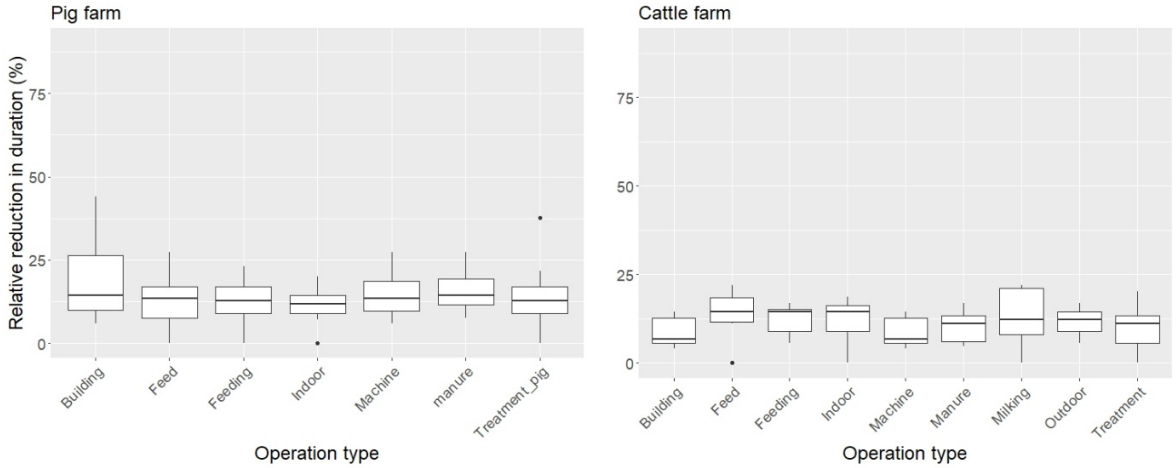

Figure S4: Estimated relative reduction in the duration of operations through the use of existing technologies on both farms.

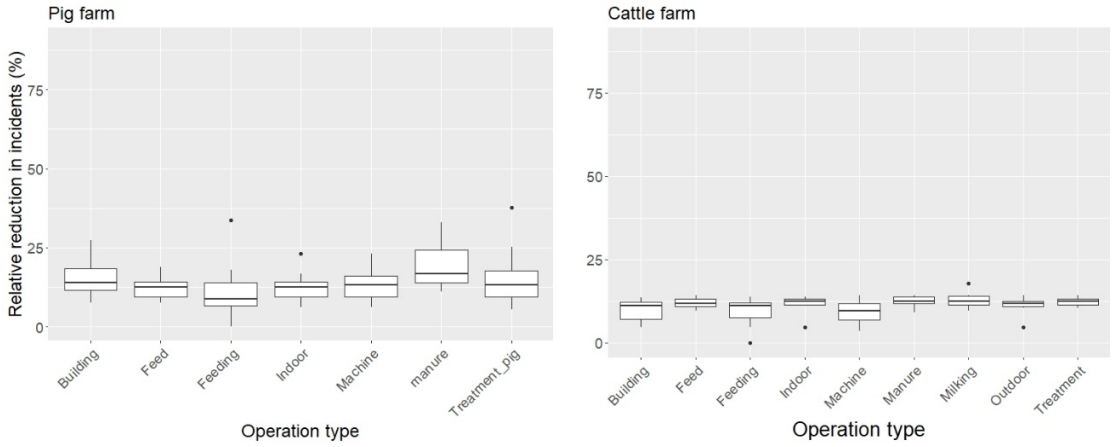

Figure S5: Estimated relative reduction in incidents through the use of existing technologies on both farms.

Future technology

Agricultural technological advancements are expected to extend the usage of information systems for improving safety on farms which will reduce the number of labor and their exposure to hazards. Experts estimated a reduction in the frequency of operations on cattle and pig farms (Figure 6). Feed production and feeding operations are the least operations with reduced frequency on cattle farms, while manure management and building repairs have the highest reduction in the frequency on pig farms. Manure management and outdoor movement of cattle considered to higher reductions in duration on cattle farms. For pig farm, there is a comparable reductions in the duration of operations, with manure management, feed production and building repairs the highest (Figure 7). Using future technology, experts considered all operations to have a reduced number of potentially dangerous incidents, with no clear pattern on cattle farm, where all operations have almost the same reduction potential. Manure management, treatment and feed production operations are estimated to have higher reductions in the number of incidents on pig farm (Figure 8).

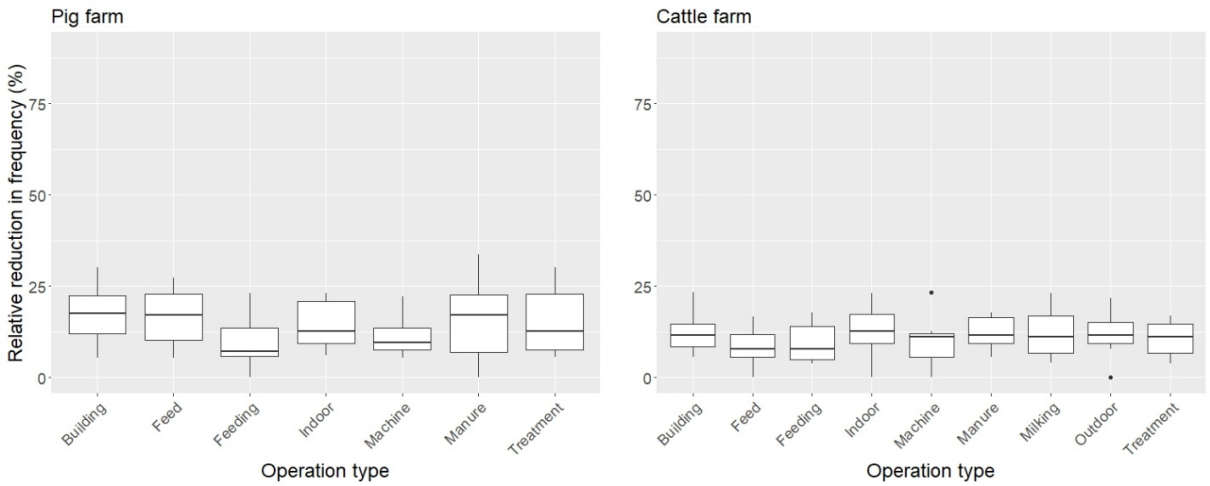

Figure S6: Estimated relative reduction in frequency of operations through the use of future technologies on both farms.

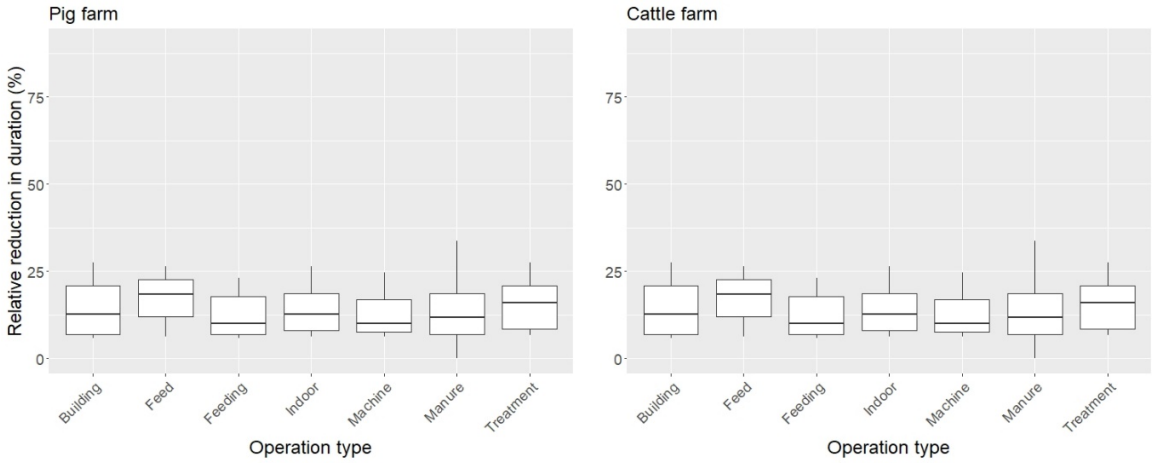

Figure S7: Estimated relative reduction in the duration of operations through the use of future technologies on both farms.

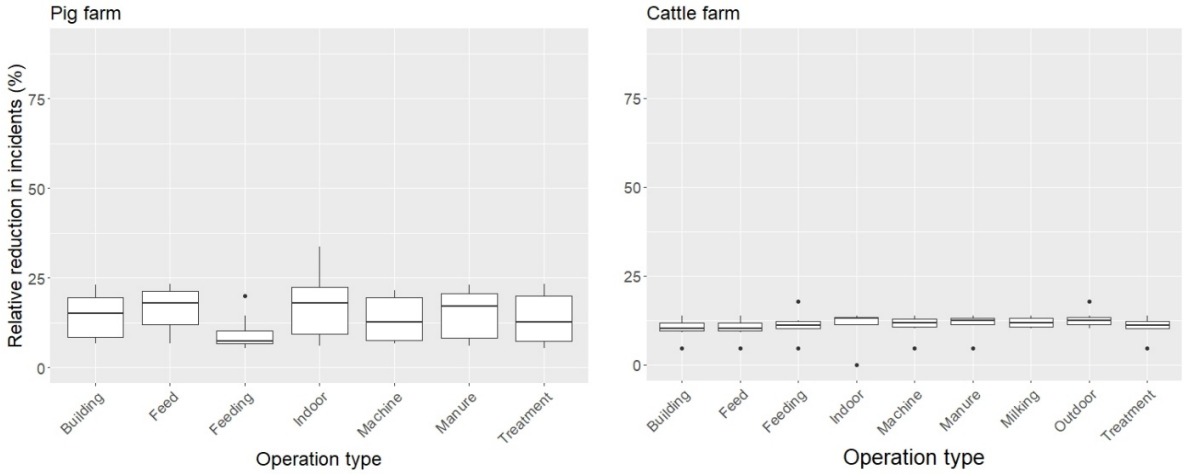

Figure S8: Estimated relative reduction in incidents through the use of future technologies on both farms.