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Scientific opinion concerning the killing of rabbits for purposes other than slaughter

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Abstract

Rabbits of different ages may have to be killed on-farm for purposes other than slaughter (where slaughter is defined as killing for human consumption) either individually or on a large scale (e.g. for production reasons or for disease control). The purpose of this opinion was to assess the risks associated to the on-farm killing of rabbits. The processes during on-farm killing that were assessed included handling, stunning and/or killing methods (including restraint). The latter were grouped into four categories: electrical methods, mechanical methods, controlled atmosphere method and lethal injection. In total, 14 hazards were identified and characterised, most of these related to stunning and/or killing. The staff was identified as the origin for all hazards, either due to lack of the appropriate skill sets needed to perform tasks or due to fatigue. Possible corrective and preventive measures were assessed: measures to correct hazards were identified for five hazards and the staff was shown to have a crucial role in prevention. Five welfare consequences of the welfare hazards to which rabbits can be exposed to during on-farm killing were identified: not being dead, consciousness, pain, fear and distress. Welfare consequences and relevant animal-based measures were described. Outcome tables linking hazards, welfare consequences, animal-based measures, origins, preventive and corrective measures were developed for each process. Mitigation measures to minimise welfare consequences are proposed.

Keywords: rabbit, on-farm killing, hazards, animal welfare consequences, welfare indicators, preventive/corrective measures

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Summary

In 2009, the European Union (EU) adopted Council Regulation (EC) No. 1099/2009 on the protection of animals at the time of killing, which was prepared on the basis of two Scientific Opinions adopted by the European Food Safety Authority (EFSA) in 2004 and 2006. Successively (in 2012, 2013, 2014, 2015 and 2017), the EFSA Animal Health and Welfare Panel (AHAW) produced other Scientific Opinions related to this subject.

In parallel, since 2005, the World Organisation for Animal Health (OIE, 2005) has developed in its Terrestrial Animal Health Code two chapters: (i) Slaughter of animals (Chapter 7.5); and (ii) Killing of animals for disease control purposes (Chapter 7.6). OIE has created an ad hoc Working Group (WG) to revise these two chapters.

Against this background, the European Commission requested EFSA to write a Scientific Opinion providing an independent view on the killing of domestic rabbits for purposes other than slaughter, which includes: (i) large-scale killings outside slaughterhouses to control diseases and for other similar situations, like environmental contamination, disaster management, etc.; and (ii) on-farm killing of unproductive animals. The animals that are considered in this assessment are rabbits kept for commercial purposes.

With specific reference to handling, restraint, stunning/killing and unacceptable methods, procedures or practices on welfare grounds, EFSA was asked to: identify the animal welfare hazards present during on-farm killing and their possible origins in terms of facilities/equipment and staff (Term of Reference (ToR)-1); define qualitative or measurable criteria to assess performance on animal welfare (animal-based measures (ABMs)) (ToR-2); provide preventive and corrective measures (structural or managerial) to address the hazards identified (ToR-3); and point out specific hazards related to species or types of animals (e.g. young ones, etc.; ToR-4). In addition, the European Commission asked EFSA to also provide measures to mitigate the welfare consequences that can be caused by the identified hazards.

This Scientific Opinion aims to update the above-reported EFSA outputs by reviewing the most recent scientific publications and providing the European Commission with a sound scientific basis for future discussions at international level on the welfare of animals in the context of killing for purposes other than slaughter (in which slaughter is defined as killing animals for human consumption).

The mandate also requested a list of unacceptable methods, procedures or practices that need to be analysed in terms of the above welfare aspects. Methods, procedures or practices cannot be subjected to a risk assessment procedure if there is no scientific evidence related to these. In the light of this, Chapters 7.5 and 7.6 of the OIE Terrestrial Animal Health Code (OIE, 2018) list principles and practices considered to be unacceptable, and the Panel has no scientific arguments to disagree with these statements.

Council Regulation (EC) No. 1099/2009[1] defines 'killing' as 'any intentional induced process which causes the death of an animal'; and the 'related operations' are 'operations that take place in the context and at the location where the animals are killed'. This Opinion concerns the killing of rabbits for purposes other than slaughter, and not involving slaughterhouses (so-called on-farm killing) and the related operations, which here are called 'processes'.

To address the mandate, two main approaches have been used to develop this Opinion: (i) literature search; followed by (ii) expert opinion through WG discussion. The literature search was carried out to identify peer-reviewed scientific evidence providing information on the aspects requested by the ToRs (i.e. description of the processes, identification of welfare hazards, origin, preventive and corrective measures, welfare consequences and related welfare indicators).

From the available literature and their own knowledge, the WG experts identified the processes that should be included in the assessment and produced a list of the possible welfare hazards present during each process related to on-farm killing of rabbits. To address the ToRs, experts identified the origin of each hazard (ToR-1) and related preventive and corrective measures (ToR-3), along with the possible welfare consequences of the hazards and relevant welfare indicators (ToR-2). Measures to mitigate the welfare consequences were also considered. Specific hazards were identified related to particular species or types of animals (ToR-4), for example those long-haired breeds that may require clipping of hair to minimise electrical resistance during electrical stunning. In addition, uncertainty analysis on the hazard identification process was carried out, limited to quantifying the probability of

[1] Council Regulation (EC) No. 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. OJ L 303, 18 November 2009, pp. 1–30.

wrongly omitting true hazards (i.e. false-negatives) or wrongly including non-hazards (false-positives) in the assessment.

The processes assessed in this Opinion are handling and stunning/killing methods. The description of the restraint, when it is needed, has been included in the assessment of the relevant stunning/killing method.

As this Opinion will be used by the European Commission to address the OIE standards, more stunning/killing methods than those reported in Council Regulation (EC) No. 1099/2009 have been considered. However, the following criteria have been applied for the selection of stunning/killing methods to include in this assessment among all methods used worldwide for on-farm killing: (i) all methods with described technical specifications known by the experts and not only the methods described in Council Regulation (EC) No. 1099/2009; (ii) methods currently used for stunning/killing of rabbits, and those which are still under development but are likely to become commercially applicable; and (iii) methods for which the welfare aspects (in terms of welfare hazards, welfare consequences, welfare indicators, and preventive and corrective measures) are described sufficiently in the scientific literature. Due to the application of these criteria, some methods that may be applied worldwide have not been included in the current assessment.

The stunning and/or killing methods that have been identified as relevant for rabbits can be grouped into four categories: (1) electrical; (2) mechanical; (3) controlled atmosphere; and (4) lethal injection.

Head-only electrical stunning is a simple (reversible) stunning method that does not lead to death; therefore, it needs to be followed by a killing method. Mechanical methods include captive bolt, percussive blow to the head and cervical dislocation. Some of these can be used as stunning and killing methods, whereas cervical dislocation is considered a pure killing method and, therefore, it must be applied on unconscious animals. For controlled atmosphere methods, no scientific evidence was available, therefore neither the feasibility of this process nor the related hazards and welfare consequences could be assessed. Lethal injection is the intravenous or intraperitoneal injection of a lethal dose of anaesthetic drugs that cause rapid loss of consciousness followed by death; it should be administered strictly following the manufacturer's instructions on dose, route and rate of administration.

In this Opinion, for each process related to on-farm killing, a description on how it is technically and practically carried out and how the rabbits are kept (e.g. if still in containers or in a restraint device) is provided. In addition, for each process, a list of the main hazards that can occur and the relevant welfare consequences that the hazards can cause is reported. In some specific cases welfare indicators are also provided as examples.

To answer ToR-1, a total of 14 welfare-related hazards have been identified during on-farm killing of rabbits. All the processes described in this Opinion have hazards. Some methods among the stunning/killing methods present hazards related to the restraint of rabbits (i.e. electrical and mechanical methods, lethal injection).

Hazards linked to failure in provoking death are the most represented ones. Some hazards are inherent to the stunning/killing method and cannot be avoided (e.g. manual restraint for captive bolt), and other hazards originate from suboptimal application of the method, mainly due to unskilled staff (e.g. rough handling, use of wrong parameters e.g. for electrical methods). In fact, all of the hazards had staff as origin and could be attributed to lack of the appropriate skill sets needed to perform tasks or due to fatigue.

The uncertainty analysis on the set of hazards identified for each process provided in this Opinion revealed that the experts were 90–95% certain that they identified all welfare hazards considered in this assessment according to the three criteria described in the Interpretation of ToRs. However, when considering a global perspective (due to the lack of documented evidence on all possible variations in the processes and methods being practised on a worldwide scale), the experts were 95–99% certain that at least one welfare hazard is missing. On the possible inclusion of false-positive hazards, the experts were 95–99% certain that all listed hazards exist during on-farm killing of rabbits.

The mandate also asked to define qualitative or quantitative (measurable) criteria to assess performance (i.e. consequences) on animal welfare (animal based measures; ToR-2); this ToR has been addressed by identifying the negative consequences on the welfare (so-called welfare consequences) occurring to the rabbits due to the identified hazards and the relevant animal based measures – here called 'welfare indicators' – that can be used to assess qualitatively or quantitatively these welfare consequences. Five welfare consequences have been identified in the context of on-farm killing of rabbits: not dead (after application of killing method), consciousness (after application of killing method), pain, fear and distress. Rabbits experience these welfare consequences only when they are conscious.

Animal welfare consequences can be the result of single or several hazards. The combination of hazards leads to a cumulative effect on the welfare consequences (e.g. pain due to injury caused by rough handling will lead to more severe pain during manual restraint for electrical stunning).

List and definitions of welfare indicators to be used for assessing the welfare consequences have been provided in this Opinion. However, under certain circumstances, not all the welfare indicators can be used because of low feasibility. Even if welfare consequences cannot be assessed during on-farm killing of rabbits, it does not imply they do not exist. In fact, if the hazard is present, it should be assumed that the related welfare consequences are also experienced by the rabbits.

In response to ToR-3, the preventive and corrective measures for the identified hazards have been identified and described. Some of these are specific for a hazard while others can apply to multiple hazards (e.g. staff training and rotation). For most of the hazards (13), preventive measures can be put in place and management was shown to have a crucial role in prevention. Corrective measures were identified for five hazards. When preventive and/or corrective measures are not available or feasible, actions to mitigate the welfare consequences caused by the identified hazards should be put in place.

Finally, outcome tables linking all the mentioned aspects requested by the ToRs (identification of welfare hazards, origin, preventive and corrective measures, welfare consequences and related welfare indicators) have been produced for each process of on-farm killing of rabbits to provide an overall outcome, in which all retrieved information is presented concisely. Conclusions and recommendations of this Scientific Opinion are mainly based on the outcome tables.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

The Union adopted in 2009 Council Regulation (EC) No 1099/2009[2] *on the protection of animals at the time of killing*. This piece of legislation was prepared on the basis of two EFSA opinions respectively adopted in 2004[3] and 2006[4] (EFSA, 2004, 2006). The EFSA AHAW Panel provided additional opinions related to this subject in 2012,[5] 2013[6-11], 2014[12,13], 2015[14] and 2017[15,16].

In parallel, since 2005, the World Organisation for Animal Health (OIE) has developed in its Terrestrial Animal Health Code two chapters covering a similar scope:

- Slaughter of animals (Chapter 7.5);
- Killing of animals for disease control purposes (Chapter 7.6)

The chapter slaughter of animals covers the following species: cattle, buffalo, bison, sheep, goats, camelids, deer, horses, pigs, ratites, rabbits and poultry (domestic birds as defined by the OIE).

The OIE has created an ad hoc working group with the view to revise the two chapters.

Against this background, the Commission would like to request the EFSA to review the scientific publications provided and possibly other sources to provide a sound scientific basis for the future discussions at international level on the welfare of animals in the context of slaughter (killing animals for human consumption) or other types of killing (killing for other purposes than slaughter).

1.1.2. Terms of Reference

The Commission therefore considers it opportune to request EFSA to give an independent view on the killing of animals for other purposes than slaughter:

- free moving animals (cattle, buffalo, bison, sheep, goats, camelids, deer, horses, pigs, ratites)
- animals transported in crates or containers (i.e. rabbits and domestic birds).

The request focuses on the cases of large scale killings which take place in case of depopulation for disease control purposes and for other similar situations (environmental contamination, disaster management, etc.) outside slaughterhouses.

The request also considers in a separate section the killing of unproductive animals that might be practiced on-farm (day-old chicks, piglets, pullets, etc.).

The request includes the following issues:

- handling,
- restraint,
- stunning/killing,
- unacceptable methods, procedures or practices on welfare grounds.

For each process or issue in each category (i.e. free moving/in crates or containers), EFSA will:

[2] OJ L 303, 18.11.2009, p. 1.
[3] The welfare aspects of the main systems of stunning and killing the main commercial species of animals, The EFSA Journal (2004), 45, 1–29.
[4] The welfare aspects of the main systems of stunning and killing applied to commercially farmed deer, goats, rabbits, ostriches, ducks, geese and quail. The EFSA Journal (2006) 326, 1–18.
[5] Electrical requirements for waterbath equipment applicable for poultry. EFSA Journal 2012b;10(6):2757.
[6] Electrical parameters for the stunning of lambs and kid goats. EFSA Journal 2013a;11(6):3249.
[7] Monitoring procedures at slaughterhouses for bovines. EFSA Journal 2013b;11(12):3460.
[8] Monitoring procedures at slaughterhouses for poultry. EFSA Journal 2013c;11(12):3521.
[9] Monitoring procedures at slaughterhouses for sheep and goats. EFSA Journal 2013d;11(12):3522.
[10] Monitoring procedures at slaughterhouses for pigs. EFSA Journal 2013e;11(12):3523.
[11] The use of carbon dioxide for stunning rabbits. EFSA Journal 2013f;11(6):3250.
[12] The use of low atmosphere pressure system (LAPS) for stunning poultry. EFSA Journal 2014a;12(1):3488.
[13] Electrical requirements for poultry waterbath stunning equipment. EFSA Journal 2014b;12(7):3745.
[14] The scientific assessment of studies on electrical parameters for stunning of small ruminants (ovine and caprine species). EFSA Journal 2015;13(2):4023.
[15] The low atmospheric pressure system for stunning broiler chickens. EFSA Journal 2017a;15(12):5056.
[16] The animal welfare aspects in respect of the slaughter or killing of pregnant livestock animals (cattle, pigs, sheep, goats, horses). EFSA Journal 2017b;15(5):4782.

- Identify the animal welfare hazards and their possible origins (facilities/equipment, staff),
- Define qualitative or measurable criteria to assess performance on animal welfare (animal-based measures),
- Provide preventive and corrective measures to address the hazards identified (through structural or managerial measures),
- Point out specific hazards related to species or types of animals (young, with horns, etc.)

1.2. Interpretation of the Terms of Reference

This Scientific opinion concerns the killing of rabbits for purposes other than slaughter. A separate opinion deals with slaughter of rabbits and is referred to in the present document.

The European Commission asked EFSA to provide an independent view on killing of rabbits for purposes other than slaughter, which takes place in case of: (a) the large-scale killings (depopulation for disease control purposes and for other similar situations, such as environmental contamination, disaster management, etc.) outside the slaughterhouses, and (b) the on-farm killing of unproductive animals. The latter could be split in two subcategories: (i) large-scale killing of unproductive animals, and (ii) individual killing on-farm including unhealthy and injured rabbits. For each of these scenarios, several welfare aspects need to be analysed (including e.g. welfare hazards, performance criteria and corrective measures).

This opinion will use definitions related to the killing of rabbits provided by the Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing, which entered into force in January 2013. In this opinion killing refers to any intentionally applied procedure that causes death of the animal (Regulation 1099/2009). The processes involved in this operation are (1) handling and (2) stunning/killing methods.

Considering that the restraint of rabbits prior to killing (or stunning if a stunning method is applied before killing the rabbit) varies depending on the killing (stunning) method, the restraint will be included in the assessment of the relevant killing (stunning) method. The main methods relevant for rabbits identified can be grouped into four categories: (1) electrical, (2) mechanical, (3) controlled atmosphere and (4) lethal injection.

Due to the diversity of available killing methods, in this opinion, the assessment of hazards, welfare consequences and related welfare indicators, hazard origin and preventive/corrective actions will be dealt with separately for each method. Mitigation measures to minimise animal welfare consequences are also described.

The mandate requests EFSA to identify hazards at different stages (processes) of killing for other purposes than slaughter and their relevant origins in terms of equipment/facilities or staff (ToR-1).

This opinion will report the hazards that occur during killing of rabbits for purposes other than slaughter, usually referred to as on-farm killing. This can be performed using several stunning/killing methods; some killing methods are specific to the on-farm killing while others are commonly used in slaughterhouses but can also be used for the on-farm killing. In the context of the same method, hazards applicable to slaughtering may occur also in the on-farm killing, whereas some other hazards may not apply due to the different scenario (e.g. hazards related to the facilities in the slaughter plant).

The mandate also asks to define qualitative or measurable (quantitative) criteria to assess performance on animal welfare (animal-based measures (ABMs); ToR-2); this ToR has been addressed by identifying the negative consequences on the welfare (so called 'welfare consequences') occurring to the rabbits due to the identified hazards and the relevant animal based measures – here called 'welfare indicators' – that can be used to assess qualitatively and/or quantitatively the welfare consequences. In some circumstances, it might be that no ABMs exist or are not feasible to use in the context of on-farm killing of rabbits; in these cases, emphasis to the relevant measures to prevent the hazards or to mitigate the welfare consequences will be given.

In this opinion, in the description of the processes, the relevant negative welfare consequences that the rabbits can experience when exposed to hazards will be also reported.

The ranking of the identified hazards in terms of severity, magnitude and frequency of the welfare consequences that they can cause would have been useful to prioritise actions and improve the procedure of the on-farm killing; however, this has not been performed due to the limited time for this mandate.

This opinion will also propose preventive and corrective measures for the identified hazards; these measures will regard two main categories: (1) structural and (2) managerial (ToR-3). When corrective measures for the hazards are not available or feasible, actions to mitigate the welfare consequences

caused by the identified hazards will be discussed. In addition, it will be assessed whether specific categories of rabbits might be subjected to specific hazards (ToR-4). As an additional request from the European Commission, measures to mitigate the welfare consequences will also be described under ToR-2.

The European Commission mandate does not specify which specific stunning/killing systems need to be included in this analysis, and the European Commission wants to use this opinion to address the OIE standards; therefore, this opinion will consider more methods than those reported in Council Regulation (EC) No 1099/2009.

Among the methods that are worldwide used for on-farm killing, EFSA has applied the following criteria for the selection of stunning and killing methods to be include in this assessment:

a) all methods with described technical specifications known by the experts and not only the methods described in Council Regulation (EC) No 1099/2009, and
b) methods currently used for stunning/killing of rabbits, and those which are still under development but are likely to become commercially applicable, and
c) methods for which the welfare aspects (in terms of welfare hazards, welfare consequences, ABMs, preventive and corrective measures) are described sufficiently in the scientific literature.

Applying these criteria will result in not including nor describing in this opinion some practices which may be applied worldwide.

The mandate also requests a list of unacceptable methods, procedures or practices which need to be analysed in terms of the above welfare aspects. The Panel considers that there are two problems with this request. First, the question of what practices are 'acceptable' or 'unacceptable' cannot be answered by scientific risk assessment, but it involves, e.g. ethical and socio-economic considerations which need to be weighed by the risk managers. Second, it has to be noted that methods, procedures or practices cannot be subjected to a risk assessment procedure if there is no published scientific evidence related to them. In the light of this, chapters 7.5.10 and 7.6 of the OIE Terrestrial Animal Health Code (OIE, 2018) list principles and practices considered unacceptable, and the Panel has no scientific arguments to disagree with these statements. The same applies to the unacceptable restraining methods listed in EC Reg 1099/2009.

2. Data and methodologies

2.1. Data

2.1.1. Data from literature

Information from the papers selected as relevant from the literature search (LS) described in Section 2.2.1 and from additional literature identified by the working group (WG) experts was used for a narrative description and assessment to address ToRs 1, 2, 3 and 4 (see relevant sections in the Assessment chapter).

2.1.2. Data from expert opinion

The data obtained from the literature were complemented by WG experts' opinions in order to identify hazard origins, welfare consequences, welfare indicators, and preventive and corrective measures relevant for the current assessment. The resulting elements were used to address the mandate extensively (see relevant sections in the Assessment chapter) and also in a concise way with development of outcome tables (see Section 2.2.2.1).

2.2. Methodologies

Two main approaches were used to develop this opinion: (i) LS and (ii) expert opinion through WG discussion.

The general principle adopted was that, when scientific literature supporting the text is available, the relevant reference/s are cited in the body of the document. When no published information is available, expert opinion will be used.

2.2.1. Literature searches

A literature search was carried out to identify hazards related to animal welfare during slaughter, stunning and killing of rabbits in peer-reviewed and grey literature.

The search was carried out in the information resources listed in Appendix A. The restrictions that were applied in the search strings were related to the date of publication: only those published after the EFSA's opinion'The welfare aspects of the main systems of stunning and killing applied to commercially farmed deer, goats, rabbits, ostriches, ducks, geese' (EFSA, 2005) were considered. No language or document type restrictions were applied in the search strings. Full details of the search protocol and strategies are provided in Appendix A.

The search yielded a total of 53 records which were exported to EndNote x7 together with the relevant metadata (e.g. title, authors, abstract). A first screening of all titles and abstracts was performed to remove articles related to species, productive systems, phases and research purposes that were out of the scope of this opinion, leading to nine records relevant to the topic of killing of rabbits. Only one record was considered relevant to the practice of on-farm killing of rabbits, whereas the other records were relevant for the description of stunning methods, related hazards and welfare consequences for rabbits.

The reference lists of relevant review articles and key reports were checked for further relevant articles. Experts were invited to propose any additional relevant publications they considered very important, including the ones published before 2005.

2.2.2. Expert opinion through working group discussion

The WG experts first described the phases and the related processes of killing and specifically which stunning/killing methods should be considered for the current assessment.

The experts then produced, from the available literature and their own knowledge, a list containing the possible welfare hazards potentially occurring during each process related to on-farm killing of rabbits. To address the ToRs, experts then identified each hazard's origin (ToR-1) and related preventive and corrective measures (ToR-3), and the possible welfare consequences and relevant welfare indicators (ToR-2). Measures to mitigate the welfare consequences were also considered.

The results of the current assessment related to ToRs 1, 2 and 3 have been summarised in tables (so called 'outcome tables', see Section 2.2.2.1); each outcome table represents a process of on-farm killing of rabbits; each row of the table reports the link among an identified hazard, the relevant welfare consequences and related welfare indicators, hazard' origins and preventive and corrective measures. Conclusions and recommendations of this scientific opinion are based mainly on the outcome tables.

2.2.2.1. Development of outcome tables linking the elements of the ToRs

A conceptual model was developed following EFSA's guidance on risk assessment in animal welfare (EFSA AHAW Panel, 2012a) which shows the interrelationships between elements corresponding to the different ToRs (see Figure 1), and the main results of the current assessment have been summarised in tables (so called 'outcome tables', see Section 3.10).

The outcome tables link all the mentioned elements requested by ToRs 1, 2 and 3 of the mandate and were produced to provide an overall outcome for each process of on-farm killing of rabbit, where all retrieved information is presented concisely (see description of the structure below and, for details, Tables 9–14). Conclusions and recommendations of this scientific opinion are mainly based on the outcome tables.

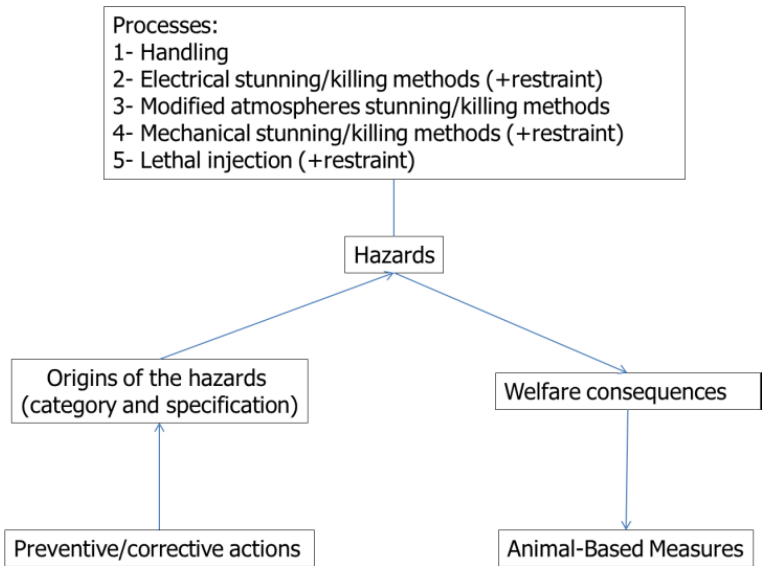

Figure 1: Conceptual model reproducing interrelationships between the elements corresponding to the different ToRs

The outcome tables have the following structure and the following terminology should be referred to:

- 'OUTCOME TABLE': Each table represents the summarised information for the processes described in the assessment (see Sections 3.3 and 3.4).
- Column 'HAZARD': in each table, the first column reports all hazards pertaining to the specific process related to on-farm killing of rabbit; the number of the section where each hazard is described in detail is reported in brackets.
- 'ROW': For each hazard, the individual row represents the summarised information relevant to the elements analysed for that hazard. Therefore, it links among an identified hazard, the relevant welfare consequences, origin/s of hazards and preventive and corrective measures (see example in Figure 2).
- Column 'WELFARE CONSEQUENCES OCCURRING TO THE RABBITS DUE TO THE HAZARD': where the welfare consequences on the rabbits due to the mentioned hazards are listed.
- Column 'HAZARD ORIGIN': this contains the information related to the main origins of the hazard; in the case of on-farm killing, it can be staff- or equipment-related. Hazards can have more than one origin.
- Column 'HAZARD ORIGIN SPECIFICATION': this further specifies the origin of the hazard. This information is needed to understand and choose among the available preventive and corrective measures.
- Column 'PREVENTIVE MEASURE/S OF THE HAZARD': depending on the origin/s of the hazard, several measures are proposed to prevent the hazard. They are also elements for implementing standard operating procedures (SOPs).
- Column 'CORRECTIVE MEASURE/S OF THE HAZARD': practical actions/measures for correcting the identified hazards are proposed. These actions may relate to the identified origin of the hazards.
- Row 'WELFARE INDICATORS': list of the feasible measures to be performed on the rabbits in order to assess the welfare consequences of a hazard (Table 1).

Table 1: Structure of outcome table (for details on the data, see Tables 9–14) with an example of a hazard from electrical stunning

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Poor electrical contact (see Section 3.6.1.6)	Consciousness, pain, fear	Staff, equipment	Lack of skilled operators, staff fatigue; incorrect placement of the electrodes; poorly designed and maintained equipment; intermittent contact, thickness of fur	Staff training; staff rotation; ensure correct presentation of the rabbits, ensure correct maintenance of the equipment; ensure the equipment includes electrodes for different sized animals; ensure continuous contact between the electrodes and the rabbits	None
Welfare indicators: (to assess the identified welfare consequences)					

2.2.2.2. Uncertainty analysis

The outcome tables include qualitative information on the hazards and related elements identified through the methodologies explained in Section 2.2.

When considering the outcome tables, uncertainty exists at two levels: (i) related to the completeness of the information presented in the table, namely to the number of rows within a table (i.e. hazard identification) and (ii) related to the information presented within a row of the table (i.e. completeness of hazard origins, preventive and corrective measures on the one side, and welfare consequences and welfare indicators on the other side).

However, owing to the limited time available to develop this scientific opinion, an uncertainty analysis for the latter level was not conducted, but only for the first level, i.e. for the hazard identification process.

In such a process of hazard identification, uncertainties may result in false-negative or false-positive hazard identifications:

- Incompleteness (false negative): Some relevant welfare related hazards may be missed in the identification process, and so will be considered non-existent or not relevant.
- Misclassified (false positive): Some welfare-related hazards may be wrongly included in the list of hazards of an outcome table without being a relevant hazard.

Incompleteness (false negatives) can lead to under-estimation of the hazards with a potential to cause (negative) welfare consequences.

The uncertainty analysis was limited to the quantification of the probability of occurrence of false-negative or false-positive hazards. Uncertainty regarding probability of occurrence of false negative hazards can relate to (i) the situation under assessment, i.e. limited to the on-farm killing practices considered in this assessment according to the three criteria described in the Interpretation of ToRs (see Section 1.2) or (ii) the global situation, i.e. including all possible variations to the on-farm killing practices that are employed in the world, and that might be unknown to the experts of the WG. The Panel agreed it was relevant to distinguish the uncertainty associated with the false-negative hazard identification for these two situations.

For false-negative hazard identification, the experts elicited the probability that at least one hazard was missed in the outcome table. For false-positive hazard identification, the experts elicited the probability that each hazard included in the outcome table was correctly included.

For the elicitation, the experts used the approximate probability scale (see Table 2) proposed in the EFSA uncertainty guidance (EFSA, 2019). Individual answers were then discussed, and a consensus judgement was elicited.

A qualitative translation of the outcome of the uncertainty assessment was also derived (e.g.'extremely unlikely' for an uncertainty of 1–5%: see Table 2).

Table 2: Approximate probability scale (see EFSA, 2019, Table 4)

Probability term	Subjective probability range	Additional options	
Almost certain	99–100%	More likely than not: > 50%	Unable to give any probability: range is 0–100% Report as 'inconclusive' cannot conclude, or 'unknown'
Extremely likely	95–99%		
Very likely	90–95%		
Likely	66–90%		
About as likely as not	33–66%		
Unlikely	10–33%		
Very unlikely	5–10%		
Extremely unlikely	1–5%		
Almost impossible	0–1%		

3. Assessment

3.1. Introduction

This section provides an overview of the practices that can be performed on-farm in the context of killing of rabbits for purposes other than slaughter (on-farm killing). The following sections (from Sections 3.2–3.4) describe in detail the processes related to on-farm killing, and are structured in two sections: (a) process description, with information on how they are technically and practically carried out and how the rabbits are kept (e.g. if still in containers or restrained); and (b) a section on related hazards and welfare consequences, where, in order to explain the impact of each process on rabbits' welfare, a list of the main hazards that have been identified in the process and the relevant welfare consequences that rabbits can experience is provided. In some specific cases, welfare indicators could be also provided as examples.

The details of the hazard characterisation and origins (ToR-1) and the full description of hazard preventive and corrective measures (ToR-3) are discussed in Sections 3.6 and 3.8, whereas specific hazards for animal categories (ToR-4) are reported in Section 3.9.

The description of the welfare consequences, of the related welfare indicators (ToR-2) and of the measures to mitigate the welfare consequences is provided in Section 3.7.

Section 3.5 deals with the unacceptable methods, procedures or practices on welfare grounds.

The preventive measures (ToR-3) that are considered general and applicable to several hazards and processes are presented in Section 3.8.

Finally, outcome tables linking each hazard to the relevant welfare consequences (and related welfare indicators), hazard's origins, and hazard's preventive and corrective measures are reported in Section 3.10.

3.2. Description of on-farm killing practices

3.2.1. Introduction

Killing of animals for purposes other than slaughter could be related to different reasons such as the culling of injured and sick individuals, needs associated with stock management, or emergency killing for disease control, management of natural disasters or other emergencies including those related to animal welfare. The methods used to cull small numbers of animals on farm are diverse and they may differ from those applied on a large scale, e.g. for depopulation.

According to the mandate, the current assessment should focus on two scenarios: (a) large-scale killing which takes place in case of depopulation for disease control purposes and for other similar situations, and (b) the killing of unproductive or surplus animals that might be practiced on farm. This second scenario can be split in two categories: (i) large-scale killing of unproductive animals and (ii) individual killing of unproductive, unhealthy or injured animals.

In the EU, rabbits are usually kept in three different systems: (i) conventional cage system; (ii) enriched cages; and (iii) pen or park housing system (European Commission, 2017). Other production systems do exist in the EU, but they are either residual in number (e.g. free range and organic or

underground cells) or used in non-commercial environments (EFSA AHAW Panel, 2020a). In modern rabbit production systems, the limited reproductive lifespan of rabbit is seen as a welfare issue. This is mainly attributed to the high culling rate of young does, caused by early death, disease and reproductive problems. According to Rommers et al. (2001, 2002, 2004), the culling rate of does in the first three parities was 30.4%, 24.4% and 26.7% for different commercial strains.

Rosell and De la Fuente (2009) determined on-farm culling and mortality in adult breeding rabbits on 130 commercial farms in Spain during 2000–2005. The median size of the farms was 595 does (minimum to maximum: 131–5500 does). At culling, does had a median age of 14.9 months and a median of 6 kindlings (births). The median monthly removal risk in does was 9.3%.

Inevitably, rabbits may have to be killed on farm for various reasons and this may involve from any or a few animals up to the entire stock in a house or whole farm. Major reasons for killing kits of different ages include respiratory and digestive disorders or being surplus to requirements/ replacement. Outbreaks or suspected cases of pasteurellosis (*Pasteurella multocida*) or highly virulent staphylococcosis (*Staphylococcus aureus*) require killing of animals in large numbers or the entire herd. Chronic mastitis is another reason for killing does, which can spread through kits that have sucked infected does and are then adopted by a different doe. Outbreaks of rabbit haemorrhagic disease (RHD) are usually managed by killing the entire herd.

3.2.2. Large-scale killing

Large-scale cannot simply be defined by setting a limit at a certain number of rabbits, as the concept should be viewed not only in terms of absolute numbers but also in relation to the total number of animals in the herd and at the farm. Outbreaks of some diseases (e.g. RHD) may warrant killing of the entire herd and some others may involve selective killing of affected animals and kits (e.g. mastitis).

3.2.3. Killing of unproductive or surplus animals

This practice can be split in subcategories:

3.2.3.1. Large-scale killing of unproductive animals

As in other animals farmed intensively for food, routine culling/killing of rabbit on farm is required to maintain good welfare, health and productive performance. Regular monitoring of rabbits enables early identification of health and welfare problems. Daily assessment is an important management tool to enhance overall rabbit health and welfare by minimising disease transmission and making early care or treatment decisions for rabbits with conditions known to cause pain or discomfort, as stated in the Code of Practice for the Care and Handling of Rabbits (NFACC, 2018). As mentioned in Section 3.2.1, rabbits will have to killed on farm for various reasons and it may involve from few animals to the entire herd in a house or on a farm, depending upon the nature of a crisis.

3.2.3.2. Individual killing

All the methods presented in Table 3 of this opinion (see Section 3.4.1) are applicable for emergency killing of individual rabbits, depending upon the availability of expertise and resources. However, cartridge powered captive bolts are the most feasible option in this context, owing to the portability of equipment and ease of use and percentage success rate.

3.3. Handling of the rabbits

3.3.1. General principles

Although domestication and subsequent genetic selection of rabbits have reduced the magnitude of fear responses, they still perceive humans as predators. Response to handling may vary between farms based on the animal species, the rearing system and the amount and nature of previous interactions with stockpersons. Careful selection of people with adequate skills and the right attitude, or their training to acquire skills appropriate to the tasks, will help to minimise poor welfare outcomes.

Guides of good practices at the time of handling and killing (European Commission, 2017) and guidelines with regard to humane handling of rabbits on farm exist (European Commission, 2017; NFACC, 2018).

Housing systems used to rear rabbits vary widely. It is therefore inevitable that the nature of hazards and the magnitude of animal welfare consequences will vary according to these factors during the life of the animals and when handled for any purpose, including killing.

In addition, the method employed for killing will also determine the nature of hazards and the number of rabbits exposed to them.

3.3.2. Process description

Whatever the housing systems and the method of killing rabbits are always caught manually.

In commercial farms, reproducing does are exclusively housed in wire cages together with their offspring until weaning age. In a large majority of specialised farms, cages are predominantly'dual purpose', i.e. for reproducing does and for fattening after weaning, which permits the all-in, all-out approach, as well as cleaning and disinfection for the following incoming reproduction cycle. These cages are equipped with a feeder, a nipple drinker and a nest area. More recently, an increasing number of new or renovated farms have been using the so-called 'WRSA cages', i.e. enriched cages that follow World Rabbit Science Association guidelines and are equipped with elevated platforms and plastic footrests, sometimes providing environmental enrichment (gnawing material). (Szendrő et al., 2019). Restocking does, but not pregnant does, are usually housed in small cages for a brief period before entering the batch production management system. Standard cages for reproducing does measure 38 cm along the shortest side, have a height of 30 cm and a minimum cage area of about 3,000 cm^2 (EFSA, 2005). In some countries, cages with a width of 46 cm are also used as standard. Enriched cages and pen/park systems have a total available surface ranging from about 4,400 to 6,400 cm^2/doe (Szendrő et al., 2019).

More recently, semi-group (part-time) housing systems have been proposed (Maertens et al., 2011) and are currently under study in different countries. In these systems, does are housed in small groups, usually from around 18 days of lactation until weaning (i.e. 3 weeks of collective housing), and individually from a few days before the following kindling until around day 18 of lactation (i.e. 3 weeks of individual housing) (Szendrő et al., 2019).

During the weaning-fattening period (28–85 days of age), rabbits are housed in cages.

Whenever it is necessary to kill a rabbit, it is necessary to remove it from the cage or park. Handling is then mandatory and can pose a problem for animal welfare if it is not carried out well.

3.3.3. Relatd hazards and welfare consequences

Even when rabbits are handled to be killed, good animal welfare should be ensured during this process through prevention of the hazards and mitigation of the welfare consequences.

As welfare consequences during this process, rabbits can be exposed to pain, fear and distress due to 'People entering the house', 'Rough handling of the rabbits', 'Inversion' and 'Unexpected loud noise'.

It should be noted that rabbits can experience pain and fear due to the exposure to the hazards related to handling at all stages of the killing on farm.

The hazards identified during 'handling', the relevant welfare consequences and related welfare indicators, hazard's origins, preventive and corrective measures are reported in Table 8.

3.4. Stunning/killing methods for rabbits

3.4.1. Introduction on stunning/killing methods and related restraint

According to Council Regulation (EC) No 1099/2009,'stunning' means any intentionally induced process which causes loss of consciousness and sensibility without pain, including any process resulting in instantaneous death. Rabbits subjected to reversible (simple) stunning methods should be killed using another method.

The list of methods and the indication whether they pertain to stunning and/or killing are presented in Table 3. This list is based on the knowledge of the WG experts as the most frequently used methods for on-farm killing. However, it may not be exhaustive in a worldwide context.

Each method will be described in detail in Section 3.4.

Table 3: Main methods used for on-farm killing of adult rabbits with an indication of whether they are stunning and/or killing methods

Method	Stunning	Killing
MECHANICAL		
captive bolt	Yes	No*
Cervical dislocation	No**	Yes
Percussive blow to the head	Yes	Yes
Blunt force trauma	Yes	Yes
HEAD-ONLY ELECTRICAL	Yes	No
LETHAL INJECTION	Yes	Yes
CONTROLLED ATMOSPHERE	Yes	Yes

*: When applied correctly, if the outcome is immediate death captive bolt can be also a killing method in rabbits. However, Council Regulation (EC) No 1099/2009 consider it a simple (reversible) stunning method.
**: Killing methods that do not render the animal unconscious immediately should be preceded by a stunning method.

For all methods, it is important to ensure that all rabbits are dead before carcass disposal (e.g. transport to the rendering plant, being buried, etc.). If animals are still alive, a back-up killing method must be applied.

It should be emphasised that the key parameters required to achieve good welfare during the application of methods listed in Table 3 have been extensively investigated and established, and hence, used globally for killing rabbits on farm.

It should also be noted that there are other methods, such as electrocution, which involves head-to-body application of a current of sufficient magnitude to induce unconsciousness and cardiac arrest, or exposure to controlled atmospheres containing carbon dioxide and inert gases until animals are dead, that have been developed and used for killing other farm animals (e.g. pigs, poultry and those farmed for fur) and some of these could be potentially modified to suit the killing of rabbits on farms.

It is also worth noting that scientific publications concerning large-scale killing of rabbits on farms are scarce and neither the hazards nor the welfare consequences are well documented. However, stunning of rabbits by head-only electrical stunning immediately followed by bleeding, killing using mechanical methods and lethal injection are described and each method has animal welfare advantages and disadvantages (NFACC, 2018). The hazards and animal welfare outcomes vary according to the method.

There is no documented scientific information on methods of killing kits on farm. Discussions with field experts revealed that unwanted kits are sometimes killed by placing them in a non-permeable bag, air is expelled as much as possible from the bag and it is tied airtight. The animals are left to die. There is no published data to suggest the time to onset of unconsciousness or death. Another method involves bagging as described above and then placing the bag in a domestic freezer. There is no published data to suggest the time to onset of unconsciousness or death. It is more than likely that kits will be subjected to death by suffocation or acute hypothermia.

3.4.2. Headonly electrical stunning

Head-only electrical stunning is widely used in rabbit slaughterhouses and can be used for on-farm stunning.

Process description

Head-only electrical stunning is applied using two electrodes on either side of the head, such that they span the brain. The electrical stunning tongs or electrodes are usually mounted on the wall, as shown below (Figure 2) (European Commission, 2018). An operator supports the rabbit's belly or holds its hind legs with one hand, and guides the head by holding the ears with the other hand. Electrodes are placed between the outer corners of its eyes and the base of its ears, away from the nose.

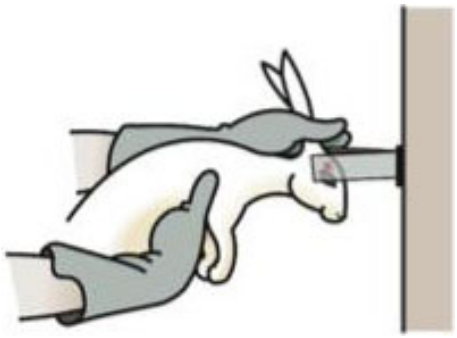

Figure 2: Illustration of head-only electrical stunning (Source: European Commission, 2018)

Alternatively, rabbit can be stunned using electrodes mounted on the ceiling by supporting its body with one hand and the other hand placed on its back to secure it in position for stunning as shown below (Figure 3).

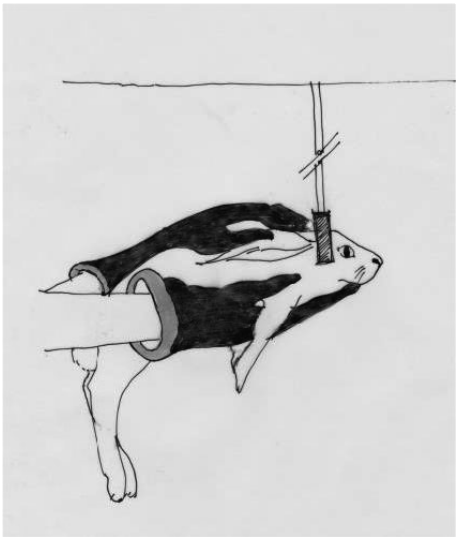

Figure 3: Head-only electrical stunning of rabbit (© Mohan Raj)

Head-only electrical stunning involves application of an electric current of sufficient magnitude to the brain of an animal causing a generalised epileptiform activity, and hence unconsciousness. The exposure time should be long enough to ensure that rabbits show proper signs of unconsciousness.

Neither the EU Slaughter Regulation 1099/2009 nor the OIE Guidelines stipulate any minimum current for head-only electrical stunning although both include rabbits. The head of a rabbit is placed in the V-shaped electrode (see Figure 2) so that the electrical current of sufficient magnitude will flow through the brain. The electrodes should be placed between the outer corners of the eyes and the base of the ears. The key parameters are the waveform and frequency of the current and the amount of current delivered to the animal required to inducing a generalised epilepsy in the brain (Anil et al., 1998; and Anil et al., 2000; Maria et al., 2001; Nodari et al., 2009). The amount of current used in the field condition ranges between 100 and 400 mA and the duration of stunning (exposure time) varies between 0.5 and 5 seconds (European Commission, 2018). The fur on the rabbit's head may impede with the efficacy of electrical stunning due to high electrical resistance. However, wetting of rabbits' heads with a damp sponge will help to overcome electrical resistance. In addition to this, the electrodes must be cleaned at regular intervals using a wire brush to facilitate good electrical contact. These measures will prevent poor animal welfare outcome due to burning of fur which occurs due to generation of heat at the contact point of the electrode.

Effectively stunned animals should be bled out by cutting both the carotid arteries within 10 seconds to prevent recovery of consciousness (European Commission, 2018).

Related hazards/welfare consequences

As welfare consequences during this process, rabbits can be exposed to 'Pain', 'Fear', 'Consciousness' due to 'manual restraint', 'Poor electrical contact', 'Too short exposure time', 'Inappropriate electrical parameters' and 'Prolonged stun to stick/kill interval'.

The hazards identified in case of 'Head-only electrical stunning', relevant welfare consequences and related welfare indicators, hazard origins, preventive and corrective measures are reported in Table 10.

Assessment of animal welfare

Head-only electrical stunning is a reversible stunning method and therefore a killing method (e.g. cervical dislocation or bleeding) should be applied. It is important to ensure that all rabbits are unconscious before applying the killing method. Signs of consciousness are: breathing, eye reflexes, spontaneous swallowing and head shacking. Death should be confirmed before carcass disposal (EFSA, AHAW Panel, 2020b).

3.4.3. Mechanical methods for adults

Mechanical methods can be used as stunning and killing methods. The main mechanical stunning/killing methods usable on farm are: (i) penetrating captive bolt, (ii) percussive blow and iii) cervical dislocation. These methods are applied to individual animals for stunning/killing.

As a precaution, it is worth mentioning that repeated firing of captive bolts in quick succession will lead to overheating of the barrel which will hinder accurate placement at the least and lead to complete failure at the worst. Therefore, there should be adequate number of captive bolts on site in order to facilitate resting/rotation of the guns.

3.4.3.1. Captive bolt

Process description

For penetrative and non-penetrative captive bolt stunning, it is essential to restrain the head to achieve accurate placement and shooting of the bolt. The rabbit should be held down with one hand on a non-slip floor, with its back end placed against something immovable so that the rabbit cannot back away. The restraining hand should gently but firmly hold the rabbit by the neck and shoulders, with the thumb and index finger lightly on either side of the rabbit's neck with rest of the hand over the rabbit's shoulders. The other hand operates the captive bolt stunner.

Recommended restraining for captive bolt stunning of rabbit: (Figure 4)

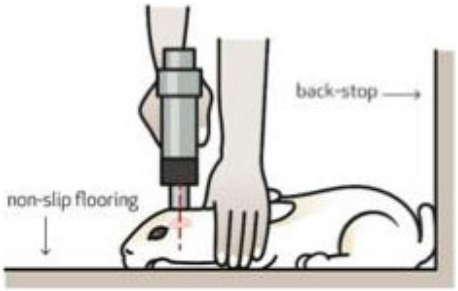

Figure 4: Restrain and position for captive bolt stunning (Source: European Commission, 2018)

Captive bolt stunning involves induction of concussion of the brain. In addition, penetrating captive bolts cause severe structural damage to the brain. Effective use of captive bolts and parameters appropriate to the size of rabbits should result in death.

Effective application of a penetrating or non-penetrative captive bolt (e.g. mushroom shaped) powered by cartridge, compressed air or spring on the frontal/parietal bones of animals and delivery of a sufficient blow to its head leads to immediate loss of consciousness due to brain concussion. The captive bolt gun should be placed firmly behind the eyes and in front of the ears and fired perpendicular to the skull bones. Both the carotid arteries should be severed swiftly to prevent recovery of consciousness. Penetrative captive bolt should be at least 6 mm in diameter (European Commission, 2018). Spring loaded captive bolts may not always deliver sufficient force and therefore requires close scrutiny.

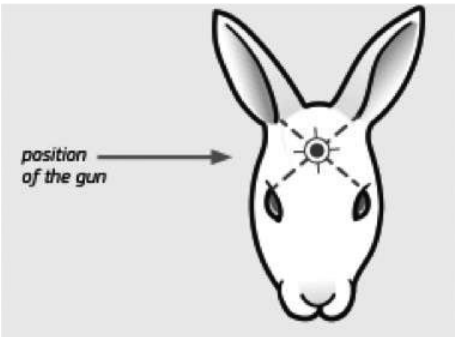

Figure 5: Position of the gun (Source: European Commission, 2018)

The operator should take into consideration some of the important variables, such as age of the animal and development and thickness of skull bones, during the selection of power of cartridge or compressed air pressure that determine the animal welfare outcomes.

Published data on the use of non-penetrative captive bolt in rabbits are scarce. Nevertheless, one study (Walsh et al., 2017) provides some data on its effectiveness. It involved the use of a commercially available gun operated by using compressed air and with a bolt extension of 2 cm beyond the muzzle of the gun (Zephyr-E, Bock Industries, Philipsburg, PA, USA).

Walsh et al. (2017) carried out a preliminary study using rabbit cadavers of varying sizes and ages and weighing between 0.9 and 4.7 kg to determine the appropriate shooting position and required airline pressure for this device. The correct location and pressure was determined by dissection of the head following application of the device looking for maximum brain damage without breaking the skin or injuring other anatomical sites. The results indicated that the appropriate pressure for sufficient brain trauma and skull fractures was 621 kPa (90 psi) for adult rabbits (> 12 weeks old), 483 kPa (70 psi) for growers (6–12 weeks old) and 379 kPa (55 psi) for preweaned kits (150 g and larger, ≤ 5 weeks old). These age-specific airline pressures are recommended by the Euthanasia Guide for Ontario Commercial Meat Rabbit Producers (2016).

Walsh et al. (2017) carried out further trials that reported 100% killed following the application of a commercially available non-penetrative captive bolt device in different age groups as shown in Table 4. This equipment is a modified pneumatically operated nail gun with a mushroom shape nylon bolt head extending 2 cm from the end of the barrel. All rabbits were successfully killed. It should be noted that this equipment was fired twice in quick succession to achieve these results; however, the authors suggested that a single shot would be adequate although did not provide additional data to support this.

Table 4: Captive bolt features (airline pressure) for various rabbit age groups (Walsh et al., 2017)

Age group	Number of animals used	Airline pressure needed	Body weight, kg (mean + SE)	Successfully killed (%)
0–5 weeks; preweaned	17	379 kPa (55 psi)	0.2 + 0.04	100%
6–12 weeks; growers	26	483 kPa (70 psi)	1.4 + 0.10	100%
> 12 weeks; adults	20	621 kPa (90 psi)	3.3 + 0.20	100%

Repeated firing of captive bolt guns will lead to overheating of its barrel and therefore requires frequent resting to cool.

Skin covering the head of rabbit can be loose in some breeds and additional care is needed to ensure effective stunning. There are also potential hazards associated with this method and the important ones are listed below. Inevitably, proper restraint is key to the successful application of the non-penetrative captive bolt. The force delivered to skulls of rabbits varies according to the power of cartridge, airline pressure or spring, and the operator should ensure that is appropriate to the age and size of the animal. It is also essential that the equipment is maintained and used according to the manufacturers' instructions.

Related hazards/welfare consequences

As welfare consequences during this process, rabbits can be exposed to 'Pain', 'Fear', 'Consciousness''Not dead', due to 'Manual restraint', 'Incorrect shooting position' and 'Incorrect bolt parameters'.

The hazards identified at 'captive bolt', relevant welfare consequences and related welfare indicators, hazard origins, preventive and corrective measures are reported in Table 11.

3.4.3.2. Percussive blow to the head

Process description

A rabbit can be suspended upside down by firmly holding both its hind legs, or restrained on a non-slippery surface with a backstop so it cannot back away. In the latter case, one hand is holding its neck and shoulder such that the ears are tucked away from the head.

A percussive blow to the head delivered with sufficient force using an iron rod, pipe or a wooden club, renders the animal immediately unconscious due to brain concussion. Some animals may be killed if the blow is severe (European Commission, 2018).

Alternatively, a rabbit can be suspended by holding its hind legs and striking it against a hard surface (Walsh et al., 2017). The striking surface can be a concrete pillar, a wall or floor. When performed with accuracy and sufficient force, the method is expected to result in immediate loss of consciousness due to brain concussion leading to death.

One published study by Walsh et al. (2017) indicated that the probability of failure was highest when adult rabbits were stunned with manual percussive blow to the head (in comparison with non-penetrative captive bolt or cervical dislocation), with a 43% chance of incorrect application and unsuccessful stun (8 of 14 adult rabbits). In addition, the results showed that ineffective stunning occurred in all age groups tested as presented in the table below. Failure was attributed to poor restraint (manual suspension by hind legs) (Table 5).

Table 5: Number of cull rabbits per age group euthanised using blunt force trauma in different age groups (Walsh et al., 2017)

Age group	Number of animals used	Body weight kg (mean ± SE)	Successfully stunned (%)
0–5 weeks; preweaned	23	0.1 ± 0.03	87%
6–12 weeks; growers	21	1.6 ± 0.10	81%
>12 weeks; adults	14	3.6 ± 0.30	57%

Potential hazards associated with percussive blow to the head are listed below. Poor restraint and operator fatigue are considered to be the major factors contributing to a low success rate with this method. The accuracy of the blow and the force delivered to the skull varies according to the operators' fitness, skill levels and compassion. For this reason, regulation 1099/2009 stipulates that percussive blow delivered manually may be used to kill no more than 70 rabbits per day.

Effective stunning of rabbits with a percussive blow induces reversible loss of consciousness (simple stunning), and therefore, the onus of preventing recovery after stunning relies on the prompt and accurate exsanguination. The earliest sign of recovery of consciousness in effectively stunned rabbit is recovery of spontaneous rhythmic breathing. Walsh et al. (2017) reported: 'A pattern predictive of a return to sensibility was convulsions suddenly stopping versus slowly fading out. No convulsions occurred when rabbits were sensible'.

Walsh et al. (2017) also cited work carried out by Li et al. (2012) who reported that a difference of 150 kPa of force applied during percussive blow delivered using a machine operated device altered the chance of mortality in 2-kg rabbits. In the study by Li et al. (2012), rabbits in the mild injury group were less likely to die from their brain injuries with only 10% mortality compared to 60% mortality in the marked injury group, as determined on the basis of lesions and extent of haemorrhaging in the brain that are considered to be characteristics of traumatic brain injury.

Related hazards/welfare consequences

As welfare consequences during this process, rabbits can be exposed to 'Pain', 'Fear', 'Consciousness''Not dead', due to 'Manual restraint', 'Inversion' and 'Incorrect application'.

Assessment of animal welfare

Death can be confirmed through the cessation of bleeding, the absence of breathing, dilated pupils and a relaxed carcass (EFSA, 2020b). If death is not confirmed, a back-up method should be applied.

The hazards identified at 'Percussive blow to the head', relevant welfare consequences and related welfare indicators, hazard origins, and preventive and corrective measures are reported in Table 12.

3.4.3.3. Cervical dislocation

Process description

Mechanically assisted cervical dislocation of adult rabbits (occasionally leading to decapitation) is routinely used in some countries. For example, the Euthanasia Guide for Ontario Commercial Meat Rabbit Producers (2016) provides the following indications:

Alignment:

1) Adjust the opening of the device to the correct size for the animal. Larger animals require a larger slot.
2) Grasp the rabbit by the scruff of the neck with the dominant hand and use the other hand to support the rabbit's hind end. Carry the rabbit to the device and slide its head into the opening. The rabbit should be facing away from the operator.
3) Once head is in device, use dominant hand to gently adjust the rabbit's head while still supporting the rabbit's weight with other hand.
4) Reposition hands so that they are on either side of the rabbit's hips grasping the upper thighs. Operator's arms should be at a 90° angle holding the rabbit at a 45° downward angle from their body.

Application:

5) With both hands on the rabbit's hips and the rabbit's head correctly positioned pull the rabbit at a 45° downward angle towards the operator's body in one quick and firm motion.

Manual cervical dislocation of kits weighing less than 150 g (preweaned kits) can be also performed by placing a narrow metal object, such as a closed pair of scissors, at the base of the skull prior to dislocation.

Application:

1) Restrain the kit on a solid surface with the animal's underside on the surface.
2) Place the object at the base of the skull with the dominant hand and firmly press the rabbit's chin to the surface.
3) Grasp the hips of the kit with the non-dominant hand.
4) Pull the rabbit's body upward away from the head and surface in one swift smooth motion at an upward angle.
5) A sizeable gap will be felt between the skull and first vertebrae.

Related hazards/welfare consequences

The hazards related to cervical dislocation include 'manual restraint' (leading to pain and fear) and 'incorrect application' (leading to the absence of unconsciousness, pain, fear and distress).

Assessment of animal welfare

The hazards identified at 'Cervical dislocation', relevant welfare consequences and related welfare indicators, hazard origins, preventive and corrective measures are reported in Table 13.

3.4.4. Lethal injections

Process description

When performed correctly using barbiturates, this is a method that stuns and kills.

Anaesthetic drugs should be injected intravenously (IV); however, intraperitoneal (IP) injection can be performed if a blood vessel is not accessible or the rabbit is too small. When the IP injection route is used, operators should ensure that the pH of drugs is not irritating, and the solution is buffered, diluted and combined with a fast-acting local anaesthetic such as lignocaine (also known as lidocaine) immediately prior to injection (Ambrose et al., 2000) to reduce irritation. It is mentioned in the MSD Veterinary Manual[17] that rabbits may jump or scream when barbiturate is given in the marginal ear vein. Therefore, sedation with midazolam (5 mg/kg, IM or IV) or propofol (10 mg/kg, IV) is recommended before administration of the barbiturate. As a further precaution, euthanasia solution

[17] https://www.msdvetmanual.com/exotic-and-laboratory-animals/rabbits/management-of-rabbits

may be diluted 1:1 with saline to prevent a negative reaction and to reduce viscosity of the solution to facilitate a faster and smoother injection.

Related hazards/welfare consequences

As welfare consequences during this process, rabbits can be exposed to 'Pain', 'Fear', 'Distress', 'Consciousness', 'Not dead', due to 'Manual restraint', 'Administration of non-anaesthetic drug', 'Inappropriate route of administration' and 'Sub-lethal dose'.

Assessment of animal welfare

The hazards identified at 'Lethal injection', relevant welfare consequences and related welfare indicators, hazard origins, preventive and corrective measures are reported in Table 14.

3.4.5. Exposure to controlled atmospheres (gas mixtures)

Controlled atmosphere stunning methods are not allowed in Council Regulation (EC) No 1099/2009 for rabbits, are not listed in Chapters 7.5 and 7.6 of the OIE guidelines and are evaluated in a limited number of research papers (Llonch et al., 2012; Nakyinsige et al., 2014; Dalmau et al., 2016). Rabbits are effectively stunned by exposure to concentrations of carbon dioxide at 70-98% and a mixture of 80% N_2 and 20% CO_2 (Llonch et al., 2012; Dalmau et al., 2016). During exposure to these gas mixtures, rabbits gradually lose consciousness. Rabbits exposed to at least 80% CO_2 will lose consciousness in on average 30 seconds, but to ensure death, they should be exposed to the gas concentration for longer periods. Dalmau et al. (2016) reported that in the case of 70% CO_2 60% of the animals died after 360 seconds of exposure. The exposure at 80% CO_2 for 170 seconds induced the death of only 68% of the animals, 90% CO_2 for 90 seconds induced the death of 75% and 98% CO_2 for 60 seconds the death of 63% of the animals. Therefore, to ensure death, the exposure time should be longer that those reported in the paper.

Furthermore, the use of slowly rising concentrations of carbon dioxide gas has been reported to be acceptable for killing preweaned kits and adult rabbits (NFACC, 2018), but the minimum standards required to achieve good welfare outcomes are not provided. For example, the rate of increase, final concentration and duration of exposure or the aversive reactions occurring in animals during the induction of unconsciousness are not known.

The exposure of rabbits to carbon dioxide, inert gases or mixture of carbon dioxide and inert gases can be used as a killing method, as it has been stipulated for killing poultry on farm. In this regard, it is envisaged that the gas mixtures can be administered (a) into houses containing rabbit rearing cages, without any need for handling conscious animals, or (b) to rabbits removed from rearing cages and placed in crates or containers which can then be loaded into a containerised gassing system.

However, scientific evidence about the procedures for on-farm killing of rabbits with controlled atmosphere methods do not exist and neither the feasibility of this process nor the related hazards and welfare consequences can be assessed.

3.4.6. Methods for on-farm killing of kits

The time courses for brain cortical and white matter development is different between species of mammals and this can influence the response to injury. Rabbit kits are considered to be neurologically moderately mature at birth (Mellor and Diesch, 2006) and perinatal brain developers (Clancy et al., 2007). Neurophysiological and electron-microscopic studies revealed the development of functional responses and myelination in projection and limbic tracts in the brain during the rapid phase of changes during the first to second week of life in rabbits (Drobyshevsky et al., 2014).

There are no documented scientific data on mechanical methods for killing kits on farm. Still, the following methods were elicited during discussions with field experts: blunt force trauma, cervical dislocation, decapitation, chilling/freezing and suffocation or smothering in a bag. However, some of these are considered not acceptable (see Section 3.5).

For all methods, it is important to ensure that all rabbits are dead before carcass disposal (e.g. transport to the rendering plant, buried, etc.). If animals are still alive, a back-up killing method must be applied.

It is important to avoid improper application of methods due to operator fatigue (Guide for Managing The Risk Of Fatigue At Work, Safe Work Australia, 2013).

3.4.6.1. Blunt force trauma

Process description:

Involves striking the back of the head of the kit with a hard implement or object. The kit's body should be held gently but firmly with one hand, with the back of the head facing away from the operator. The head of the kit should be struck accurately and with sufficient force against a hard surface. A suitable killing method needs to be applied immediately.

3.4.6.2. Cervical dislocation

Process description:

Involves restraining of the kit on a solid surface with one hand, placing a narrow, blunt metal object such as closed pair of scissors on the base of the skull and firmly pressing the kits chin to the surface, grasping the hip of the kit with the other hand and pulling its body upward and away from the head and surface in one swift and continuous motion.

Blunt force trauma should be used as a method to stun the kits before performing cervical dislocation. Cervical dislocation by crushing should not be used.

3.4.6.3. Decapitation

Process description:

Placing a pair of scissor/shear blade at the base of the skull and the top of the neck and cutting through in one swift, smooth motion.

Blunt force trauma should be used as a method to stun the kits before performing decapitation.

3.4.6.4. Chilling/freezing (leading to hypothermia)

Process description:

Placing kits in a domestic freezer and let them die due to hypothermia.

3.4.6.5. Suffocation or smothering in a bag

Process description:

Bagging large number of kits and leaving them to die due to the lack of air.

3.5. Unacceptable methods, procedures or practices on welfare grounds

The mandate requests to identify unacceptable methods in terms of welfare. The Panel considers that there are two problems with these requests. First, the question of what practices are acceptable cannot be answered by scientific risk assessment, but rather involves, e.g. ethical and socio-economic considerations that need to be weighed by the risk managers. Second, it should to be noted that methods, procedures or practices cannot be subjected to a risk assessment procedure if there is no published scientific evidence relating to them.

Nevertheless, the panel has no scientific arguments to disagree with OIE and EC Regulation 1099/2009 on unacceptable methods and practices.

EC Regulation 1099/2009 presents a list of methods of restraint which are prohibited. Some of these methods are related to rabbit killing.

(a) suspending or hoisting conscious animals;
(b) mechanical clamping or tying of the legs or feet of animals;
(c) severing the spinal cord, such as by the use of a puntilla or dagger;
(d) the use of electric currents to immobilise the animal that do not stun or kill it under controlled circumstances, in particular, any electric current application that does not span the brain.

Similarly, the Panel has no arguments to disagree with the principle in Chapter 7.5.10 of the OIE Terrestrial code (World Organisation for Animal Health (OIE), 2018), which says that 'methods and practices e.g. restraining methods [...] that cause severe pain and stress in animals, cannot be considered acceptable'.

In addition to this, in Chapter 7.6 the Code refers to the principle that 'when animals are killed for disease control purposes, methods used should result in immediate death or immediate loss of consciousness lasting until death; when loss of consciousness is not immediate, induction of unconsciousness should be non-aversive and should not cause anxiety, pain, distress or suffering in animals'.

Again, the Panel has no reason to disagree with this principle and considers it a basis for acceptability. As a result, the panel agrees that the following are examples of methods that should not be used on welfare grounds: killing rabbits by burying, burning, drowning, suffocating, chilling/freezing and the addition of poisons, pesticides or any other toxic substances to feed or water for the purpose of killing.

3.6. Response to ToR-1: hazard identification, origin and specific preventive and corrective measures

According to EFSA (2012), a hazard is any aspect of the environment of the animal in relation to housing and management, animal genetic selection, transport and slaughter, which may have the potential to cause poor welfare.

In this opinion, hazards have been identified through the activities described in Section 2.2 and analysed for each phase and process under consideration. The hazards listed in the following sections are related to conscious animals.

According to the mandate, the possible origin of the hazards, in terms of facilities/equipment or staff, should also be identified. When discussing these categories, it was agreed that the 'origin' can be explained further by detailing which actions from the staff or features from equipment and facilities can cause the hazard.

Therefore, for each 'origin category' (facilities/equipment, staff), relevant explanations (so called 'origin specifications') have been specified.

The mandate also requests to identify the preventive and correctives measures related to the identified hazards. Quite often, hazard corrective measures do not exist. In this case, measures to mitigate the welfare consequences can apply. However, most of the times the main mitigation measure is to kill the animal as soon as possible (see also Section 3.7.1). In the case that the killing method fails, a back-up method should be applied to mitigate severe welfare consequences such as pain, fear and distress. When preventive and corrective measures can be identified, if they are specific for a particular hazard, they will be described in this section together with the relevant hazard. If the preventive and corrective measures available can apply to several hazards (general measures), they will be described under Section 3.8 (response to ToR-3). When no further explanation is needed, reference to the outcome tables will be made.

The full list of the 14 hazards identified (see Table 6), with their definitions, indication of which process they apply to and relevant preventive and corrective measures, are reported in the following sections. In particular, hazards specific to the category of kits are reported in Section 3.9.

The identified hazards with relevant origin categories and origin specifications, are listed in the outcome tables (Tables 9–14; Section 3.10: first column – hazards, third column – origin category, fourth column – origin specification). In addition, considering that each hazard may lead to one or more negative consequences on the welfare of the rabbits, the outcome tables also report the welfare consequences with which each hazard is associated (second column of the outcome tables mentioned above).

3.6.1. List of hazards

3.6.1.1. People entering the house

Definition: people related to the operation entering the house in a way that cause fear to the animals.

Process to which this hazard applies: handling

Hazard's preventive and corrective measures

The man-animal relationship assumes particular importance in rabbits, due to their shyness and diffidence towards man. In rabbit farms, contacts between animal and man begin soon after birth and continue to be frequent, so usually a positive relationship free from fear of man is developed. In fact, fear levels fall when animals become accustomed to human presence and contact, but the arrival of large numbers of strangers can stress rabbits (Trocino and Xiccato, 2006). This hazard is unavoidable since it is a part of the method. The only thing that can be done is to minimise disturbance as much as possible.

3.6.1.2. Rough handling of the rabbits

Definition: handling of the animals in a way that cause pain and fear and distress. Handling of animals by legs or ears is inappropriate and can cause pain, fear and distress.

Rough handling applies to different actions such as: catching, carrying rabbits by ears or legs, put rabbits in containers, remove rabbits from containers or farm cages, move them from a point to another by handling them.

Process to which this hazard applies: handling

Hazard's preventive and corrective measures

Rabbits should be removed from the cages or containers individually by holding and lifting by the neck skin (scruff) by one hand, with or without support of the body with the other hand (European Union, 2017; Figure 6). Once outside the cage or containers, their body should be supported with the other hand.

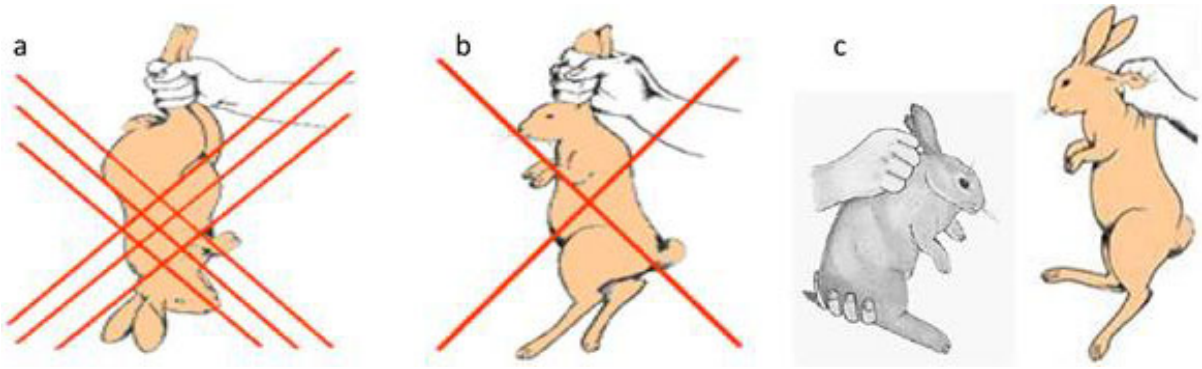

Figure 6: Poor practice of grasping rabbits by the hind legs (a) or by the ears (b) and good practice of grasping rabbits by the skin of the neck (c) (Source: European Union, 2017)

Staff rotation is important to avoid fatigue of workers that can lead to increase a worker's hazard exposure by reducing mental and physical functioning, impairing judgement and concentration, lowering motivation, slowing reaction time and increasing risk-taking behaviour (Guide for Managing The Risk Of Fatigue At Work, Safe Work Australia, November 2013), which are all factors that can lead to poor rabbits handling practices. Therefore, staff training and rotation are the most effective preventive measure. In case the hazard still happens, a way to prevent its occurrence can be to slow down speed. There is no corrective measures to this hazard.

Containers (crates) used for movement of rabbits should be placed as close as possible to the animals for loading in order to minimise operator fatigue and the distance live animals are carried.

3.6.1.3. Unexpected loud noise

Definition: a noise that by its level suddenly induces fear to rabbits.

It is important to limit the unexpected loud noise that will lead to distress and decrease coping capacities.

Process to which it applies: handling

Hazard's preventive and corrective measures

The preventive measure will consist in staff education and training: (i) to make them aware that the noise should be avoided and (ii) to make them avoid shouting and making noise with the machines/containers, and identify and eliminate the sources of noise. Once the noise has been emitted, there is no way to correct the hazard but only the welfare consequence (e.g. fear)

3.6.1.4. Inversion

Definition: holding rabbits in an upside–down position.

This situation can happen: (1) in the process of handling when rabbits are carrying by operators and (2) during the process of restraint for application of percussive blow to the head.

Processes to which this hazard applies: restrain for percussive blow to the head

Hazard's preventive and corrective measures

To avoid the inversion of conscious animals it is preferable to choose a different method.

3.6.1.5. Manual restraint

Definition: catching and immobilisation of the rabbit with the hands of an operator.

Processes to which this hazard applies:

restraint for: mechanical stunning methods, head-only electrical stunning and lethal injection.

Hazard's preventive and corrective measures

Poor restraint can lead to misapplication of the stunning method.

Rabbits should be manually restrained firmly enough to facilitate the stunning, but without excessive pressure that will cause pain and fear. There is no preventive and corrective measure to this hazard. The only thing that an operator can do is perform it in the appropriate way which have been described in Section 3.4. The welfare consequences pain and fear can be mitigated.

3.6.1.6. Poor electrical contact

Definition: the electric contact is not sufficient to facilitate flow of current to immediately stun/kill the rabbits. This can result from: (a) an incorrect placement of the electrodes that do not span the brain, (b) an intermittent contact and (c) the use of dirty/worn electrode(s).

In case of intermittent contact, the desired flow of current through the brain is not achieved.

Dirt (e.g. originating from the rabbits' fur or carbonised debris) may accumulate on the electrodes leading to increased resistance to the current flow. The electrodes corrode over a period of time due to repeated use, poor maintenance and lack of replacement leading to increased resistance of the current flow and localised heat generation. The good position of electrodes is very important.

Processes to which it applies: head-only electrical stunning

Hazard's preventive and corrective measures

In the case of head-only electrical stunning, ensure correct presentation of the rabbit and ensure equipment includes electrodes for different sized animal in order that the current will flow easily through the brain. Electrodes must be properly constructed to en-sure contact with skin through the rabbit's fur. Placing water on the head of the rabbit reduces resistance. Four options are available for correct electrode placement for the head-only method, including on both sides of the head between the eye and ear, the base of the ear on both sides of the head, and diagonally below one ear and above the eye on the opposite side of the head (AVMA, 2013, 2016).

3.6.1.7. Too short exposure time

Definition: the duration of exposure to the electrical current is too short to result in epileptiform activity in the brain leading to unconsciousness or resulting in recovery of consciousness.

Anil et al. (1998, 2000) reported that a minimum of 100 volts delivered using a 50-Hz sine wave alternating current for one-second resulted in an average current of 140 mA and is sufficient to induce unconsciousness and prevent recovery of consciousness, provided the stun-to-stick interval is less than 10 seconds.

Processes to which it applies: head-only electrical stunning

Hazard's preventive and corrective measures: measures aimed at maintaining adequate exposure time, or at increasing it will prevent or correct this hazard (see Table 10).

3.6.1.8. Inappropriate electrical parameters

Definition: the electrical parameters (i.e. voltage, current, frequency, waveforms) fail to achieve epileptiform activity in the brain. It is caused for example by: too low voltage to generate sufficient current to achieve an effective stun, frequency too high to cause immediate unconsciousness, high electrical resistance of the rabbit in the system that prevents the current flow through the brain of the rabbit to cause immediate unconsciousness.

Processes to which it applies: head-only electrical stunning

Hazard's preventive and corrective measures

To prevent the use of inappropriate electrical parameters, in the case of head-only electrical stunning, the responsible person of the on-farm killing should use the parameters appropriate to the frequency and waveforms of the current. The main parameter that needs to be considered is the minimum current delivered to the rabbits, which depends upon the output voltage from the equipment. The minimum current required to achieve effective stunning of rabbits is reported in Section 3.4.2. However, to ensure the

voltage is sufficient to deliver minimum current, the responsible person of the on-farm killing should as a best practice evaluate the effectiveness of the electrical parameters monitoring signs of unconsciousness. In this evaluation process, the factors that could contribute to high electrical resistance in the pathway (e.g. density of fur and of bones, the design and construction of the electrodes) should be identified and ways of minimising or eliminating them should be explored (e.g. wetting of the heads, selecting materials and design that offers least electrical resistance) (Humane Slaughter Association, 2017). Wetting of rabbit's head with a damp sponge helps to minimise electrical resistance. Cleaning of electrical stunning tongs routinely with a wire brush eliminates accumulation of dirt and fur and minimise resistance. Another way of overcoming the problem of high resistance is using a constant current stunner. Implementation of such an equipment will greatly benefit rabbit welfare during on-farm killing. In rabbits, 50 Hz is the most commonly frequency used. No measures have been identified to correct this hazard.

3.6.1.9. Prolonged stun to kill interval

Definition: the interval between end of stunning and the application of a killing method is too long to sustain unconsciousness until death occurs.

This is a hazard leading to recovering of consciousness.

Process to which it applies: head-only electrical stunning and associated killing method.

Hazard's preventive and corrective measures:

ensuring back up neck cutting, reduce stun to neck cutting interval.

Research has shown that the time to return of spontaneous breathing in head-only electrically-stunned rabbit was 22 seconds (Anil et al., 2000) and an EU-wide survey of best practices in rabbit slaughterhouses indicated that maximum stun-to-stick interval is 10 seconds, exceptionally 20 seconds in one slaughterhouse (European Union, 2017). It is recommended to keep the stun-to-stick interval to less than 10 seconds. Staff should be trained to perform prompt and accurate neck cutting.

If poor bleeding is suspected or observed after the cut, repeat cut should be performed immediately, and animals should be re-stunned prior to repeat cut if they show signs of consciousness.

3.6.1.10. Incorrect shooting position

Definition: when the captive-bolt is positioned wrongly, unconsciousness of the rabbits might be not achieved. The captive-bolt should be placed at the intersection of lines drawn from the lateral canthus of each eye to the opposite ear, perpendicular to the skull bones (see Figure 5).

Shooting of rabbits with a non-penetrating captive bolt on the head, i.e. frontal-parietal bones, induces brain concussion and immediate loss of consciousness. Proper restraint of the animal and presentation of its head are vital to achieve this. However, skin covering the rabbit's head can be loose in some breeds and, owing to this, and bolt may skid or slide leading to failure.

Process to which it applies: captive bolt stunning

Hazard's preventive and corrective measures: training of staff and appropriate restraint.

3.6.1.11. Incorrect bolt parameters

Definition: the bolt parameters fail to provoke an effective stun and to render rabbits' unconscious. It is caused for example by: low airline pressure, low cartridge power, low bolt velocity, shallow penetration and faulty equipment (too narrow bolt diameter).

Processes to which it applies: captive bolt

Hazard's preventive and corrective measures: use equipment fit for the purpose

3.6.1.12. Incorrect application of blow to the head and cervical dislocation

Definition: when the rabbits are hit in the wrong place (blow not delivered to the occipital region of the skull, just behind the ears), or with a force not sufficient to cause brain concussion.

One published study by Walsh et al. (2017) indicated that the probability of failure was highest when adult rabbits were stunned with manual percussive blow to the head (in comparison with non-penetrative captive bolt or cervical dislocation), with a 43% chance of incorrect application and unsuccessful stun. In addition, the results showed that ineffective stunning occurred in all age groups tested. Failure was attributed to poor restraint (manual suspension by hind legs).

Poor restraint and operator fatigue are considered to be the major factors contributing to a low success rate with this method. The accuracy of the blow and force delivered to the skull varies according to the operators' fitness, skill levels and attitude.

For cervical dislocation, it may happen due to:

- A too slow stretching or twisting of the neck. In fact the manual or mechanical separation of the spine from the head should be carried out quickly and firmly, in one continuous motion (European Commission, 2017).
- The lack of separation of the brain and spinal cord that can occur for intact brain and spine or of incomplete separation or crushing of the spine.
- The incomplete severance of the carotid arteries leading to death: failure to completely severe both carotid arteries leading to sustained oxygenated blood supply to the brain.

Although direct scientific evidence is lacking, expert opinion expressed in a previous EFSA Opinion (2006) states that death is not instantaneous for cervical dislocation, and the inflicted tissue damage may be perceived as painful. Therefore, cervical dislocation should only be used for killing stunned rabbits.

Processes to which it applies: percussive blow and cervical dislocation

Hazard's preventive and corrective measures: appropriate tool and sufficient force. Operator rotation to avoid fatigue.

3.6.1.13. Inappropriate route of administration of lethal drugs

Definition: any route of administration different from the ones recommended by the manufacturer.

It could include the wrong route of administration and the accidental spillage of irritating drug from intended route of administration. Drugs that are intended for intravenous administration may have to be suitably buffered for intraperitoneal administration following the manufacturer's instruction.

Process to which it applies: lethal injection

Hazard's preventive and corrective measures: use appropriate restraint and presentation of the animal to avoid extravasation of the drug.

3.6.1.14. Sub-lethal dose

Definition: use of a dose inferior to the one recommended by the manufacturer to kill a rabbit.

The dose of an anaesthetic drug needs to be calculated carefully according to the body weight of individual animal. Doses lower than necessary to kill animals will lead to recovery of consciousness later.

Process to which it applies: lethal injection

Hazard's preventive and corrective measures: use the correct dose according to live weight of rabbits.

3.6.2. Overview of hazards in the different processes

Table 6: Overview of hazards during the diverse processes of on-farm killing of rabbits (for Hazard's description see Section 3.6.1)

Hazard	Handling	Head-only electrical	Captive Bolt	Percussive blow	Cervical dislocation	Lethal injection
People entering the house	X					
Rough handling of the rabbits	X					
Unexpected loud noise	X					
Inversion				X		
Manual restraint	X	X	X	X	X	X
Poor electrical contact		X				
Inappropriate electrical parameters		X				
Prolonged stun to stick interval		X				
Too short exposure time		X				
Incorrect shooting position			X			
Incorrect bolt parameters			X			
Incorrect application of blow to the head and cervical dislocation				X	X	

Hazard	Handling	Head-only electrical	Captive Bolt	Percussive blow	Cervical dislocation	Lethal injection
Inappropriate route of administration						X
Sublethal dose						X
Total n. of hazards	**4**	**5**	**3**	**3**	**2**	**3**

3.6.3. Assessment of uncertainty

Uncertainty related to the occurrence of false-negative and false-positive hazards was assessed (see methodology described in Section 2.2).

Regarding the possible occurrence of false-negative hazards, the experts were 90–95% certain that they identified all welfare hazards considered in this assessment according to the three criteria described in the Interpretation of ToRs. However, when considering a global perspective, the experts were 95–99% certain that at least one welfare hazard is missing. This is due to the lack of documented evidence on all possible variations in the processes and methods being practiced on a worldwide scale (see Interpretation of ToRs on the criteria for selection of stunning/killing methods to be included).

Regarding the possible inclusion of false-positive hazards, the experts were 95–99% certain that all listed hazards exist during on-farm killing of rabbits.

3.6.4. Origin categories and specifications

On the basis of experts' knowledge, the origins of the hazards have been identified and categorised in terms of equipment or staff, as required by the mandate.

The category of 'staff' includes all the personnel involved in unloading, movement, restraint, stunning and killing of rabbits, including special personnel hired if there is large-scale depopulation.

'Equipment' includes machinery or tools used on live rabbits for handling, moving, restraining, stunning and killing. For example, containers used for transporting rabbits, forklift used for unloading, shelter system to protect rabbits, stunning devices and associated calibrating and monitoring systems, and knives or mechanical cervical dislocation devices subsequently used for killing rabbits.

'Staff' origin contributes to most of the hazards. Almost all the hazards originating from staff could be attributed to lack of the appropriate skill sets needed to perform tasks or to fatigue and therefore have preventive measures, which includes recruitment of people with right attitude and aptitude, staff training and staff rotation. This applies with special emphasis when specific staff are needed (e.g. for large-scale killing). In the cases of individual killing, the 'staff' is the farmer or his employees.

'Equipment' is an important category contributing to the second highest number of hazards in all the phases, especially during stunning.

Inevitably, preventive or corrective measures appropriate for a hazard vary according to the origin category. The proportion of rabbits subjected to hazards can also vary according to the origin category.

An overview of the origin category(ies) pertaining to each of the hazards identified in the sections above is reported in Table 7.

Relevant origin specifications have been reported in the outcome tables developed by processes of the on-farm killing (see Section 3.10).

Table 7: Overview of the origin categories relevant to the hazards identified for the assessed processes

Hazards	Staff	Equipment
People entering the house	X	
Rough handling of the rabbits	X	X
Unexpected loud noise	X	X
Inversion	X	
Manual restraint	X	
Poor electrical contact	X	X
Too short exposure time	X	

Hazards	Staff	Equipment
Inappropriate electrical parameters	X	X
Prolonged stun to kill interval	X	
Incorrect application of the blow and cervical dislocation	X	X
Incorrect shooting position	X	
Incorrect bolt parameters	X	X
Inappropriate route of administration	X	
Sublethal dose	X	

3.7. Response to ToR-2: Criteria to assess performance on animal welfare (including welfare indicators)

The mandate requests to define animal-based measures (welfare indicators), that can be used to assess welfare performance; in this opinion, welfare performance is addressed by analysing the potential negative welfare consequences occurring to the animals due to the identified hazards. Furthermore, ABMs (welfare indicators) that can be used to assess qualitatively or quantitatively the welfare consequences were evaluated and a set of welfare indicators was selected to be included in the outcome tables.

3.7.1. Welfare consequences

There are several potential (negative) welfare consequences that a rabbit can experience when killed on farm. However, due to the complexity of the circumstances during killing procedures (e.g. disease control), not all the welfare consequences can be assessed.

Five welfare consequences occurring to rabbits during the processes of on-farm killing have been identified by the experts: pain, fear, distress, consciousness and the absence of death. Consciousness is the prerequisite for the perception of any of the first three. Some of the welfare consequences are specific to the handling of the animals or to people entering the facilities, others are specific to the killing procedure (consciousness, death).

To identify the welfare consequences, several welfare indicators that can be applied for on-farm killing situations as well have been reported (EFSA, 2019; EFSA AHAW Panel, 2020a); for the assessment of the efficacy of the killing processes, qualitative and measurable criteria can be used. Parallel to the current opinion, EFSA developed a Scientific Opinion on the slaughter of rabbits for human consumption (EFSA AHAW Panel, 2020a) where welfare indicators for consciousness and signs of life have been selected based on their specificity and sensitivity. The 'toolboxes' developed for the different stunning methods can be useful also for on-farm killing assessment of consciousness. In this regard, the expected outcome after the application of a single or combination of methods is death in all the animals, which should be confirmed before carcass disposal. If a reversible stunning method, such as head-only electrical stunning, is used to render rabbits unconscious, then unconsciousness should be confirmed prior to immediate application of a killing procedure such as induction of cardiac arrest or bleeding.

The welfare consequences that have been identified as the ones that rabbits can experience when killed on farm are described below in this section. Relevant welfare indicators are also listed, and they will be described in detail in the following Section 3.7.2. Finally, the measures that can be used to mitigate the welfare consequences are reported.

Fear

Description: Fear has been defined as 'a feeling which occurs when there is perceived to be actual danger or a high risk of danger'; it can produce changes in behaviour, physiology and in the brain (Broom and Fraser, 2015). Excessive fear may cause chronic stress, which affects animal welfare and health (Forkman et al., 2007). Moreover, excessive fear may cause serious trauma and injuries during handling when animals struggle and are difficult to be handled.

As prey animals and because of their recent domestication, rabbits are widely recognised as tame or fearful towards man, predators and any stimulus. However, recent studies have demonstrated that changes in brain architecture of domestic rabbits are consistent with altered fear processing and, thus, compared with their wild ancestors, domestic rabbits are less fearful and have an attenuated flight response (Brusini et al., 2018).

Fear can be elicited by different occasional stimuli or even by defective management practices and housing conditions, which can affect animals' response and welfare to a different extent depending on the frequency of occurrence, duration and severity of the threat. In the on-farm killing situation, rabbits might experience fear during handling and removing of animals from containers and during phases 2 and 3 (stunning and bleeding).

Welfare indicators:

Rabbits react to fear or threat by 'fight-or-flight' response, but also manifest tonic immobility (also defined as immobilisation catonia or death feigning) (Giannico et al., 2014). Under different conditions (farmed, lab or pet rabbits), when exposed to threats (noises, the presence of man or unknown operators, introduction of new animals into an established group), rabbits have been observed running away into a hiding place or into a corner of the cage, or freezing, or attacking with teeth and claws (Mullan and Main, 2006; Crowell-Davis, 2007; Verga et al., 2009).

Measurements of fear levels in rabbits have been based on changes in posture, inhibition of normal behaviour or occurrence of some abnormal behaviours, altered response to reactivity tests as well as physiological indicators (EFSA, 2005; Verga et al., 2009; Verwer et al., 2009; Buijs and Tuyttens, 2015; Trocino et al., 2018). Indeed, as for the other species, the interpretation and evaluation of the results require special care and an approach as much as possible comprehensive, since some behavioural and physiological indicators are associated with more than one poor welfare state (Broom and Fraser, 2015). Hampshire and Robertson (2015) suggested that the Rabbit Grimace Scale can be used to assess pain and distress, which are negative mental states like fear, and therefore, the use of this scale for assessing fear needs to be explored.

Signs of fear are not easily recognisable while animals are housed in containers. Possible welfare indicators during handling outside the container are:

1) Escape attempts, flight (escape)
2) Vocalisations
3) Tonic immobility
4) Grimacing

Mitigation measures:

Mitigation measures are to identify and eliminate the source of fear, where possible.

Pain:

Description: Pain can be defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (International Association for the Study of Pain). Most of the processes of killing are potentially painful for conscious animals (see Tables 9–14). They include rough handling, miss-stunning and the injection of non-anaesthetic substances.

Welfare indicators:

Since pain is a subjective feeling, its intensity, or even the presence, can be very difficult to diagnose, especially in prey species which have been subject to evolutionary pressure to minimise external signs of this state. There are few validated assessment tools for pain assessment in farmed rabbits, but there has been extensive research into pain assessment in laboratory rabbits and this knowledge can be applied in the context of rabbits farmed for meat. Laboratory research has validated changes in natural behaviour, facial expressions and body temperature for pain assessment (Farnworth et al., 2011; Leach et al., 2011; Keating et al., 2012). Behavioural changes include reduced feeding and drinking, tight huddle posture (sitting with their back arched and fore and hind limbs drawn in tightly), locomotory changes including shuffle (walking at a very slow pace) and partial hop movements (forward extension of forelimbs as if to hop, without movement of hind limbs) (Farnworth et al., 2011). General grooming is also reduced, although sites of injury may receive increased grooming (Farnworth et al., 2011). EFSA (2005) noted that although rabbits are normally silent animals, they may squeal loudly if in severe pain or distress; they may also grind the teeth in cases of more chronic pain. More recently, the use of facial expression (i.e. grimacing) as an indicator of pain has been validated in rabbits (Keating et al., 2012). The Rabbit Grimace Scale assesses five different facial action units (orbital tightening, cheek flattening, nose shape, whisker position and ear position) to create an overall score that increases when rabbits experience pain.

From all of the above welfare indicators, vocalisations seem to be the most practical one to assess pain during killing. In addition, withdrawal responses or escape attempts from painful stimuli are also indicative of pain. In addition, pain can be indirectly assessed by scoring the injuries. Feasible welfare indicators are physical damages to the muscles and skin (e.g. scratches and open wounds, bruises). Traumatic injuries during post-mortem inspection are considered to be an indicator for poor handling causing negative welfare consequences.

Therefore, possible welfare indicators to monitor the killing process are:

1) Vocalisations
2) Injuries to muscles and skin
3) Withdrawal reactions, escape attempts
4) Grimacing

Mitigation measures:

Preventative measures should be aimed at the avoidance of injuries during handling and at correct stunning and killing procedures. Staff training is an important element.

There are no mitigating measures during the stunning process, other than to proceed as effectively as possible.

Distress:

Description: Distress is a welfare status difficult to describe, assess and quantify; however, it is a negative welfare consequence that animals can experience in addition to (and different than) pain and fear. It can be a mental or physical suffering, such as extreme anxiety or fear, impossibility to cope with environmental conditions, sadness, or pain, or the state of being in danger or urgent need.

For on-farm killing, rabbits are exposed to a number of distressing situations in a short period of time. People are entering the building, which can induce anxiety and fear followed by catching and handling the animals causing fear. When not handled with care, it causes injuries and can be painful. Different hazards will lead to a combination of welfare concerns including distress.

Welfare indicators:

No specific welfare indicators have been identified to assess distress. However, depending on the origin of mental suffering welfare indicators for pain (see pain) or fear (see fear) or thermal stress (see thermal stress) can be applied. Hampshire and Robertson (2015) suggested that the Rabbit Grimace Scale can be used to assess pain and distress.

Mitigation measures: end the process as quickly as possible in order to reduce the time rabbits experience this welfare consequence.

State of consciousness:

Description

Consciousness is the ability of an animal to feel emotions, be sensitive to external stimuli and able to control its voluntary mobility. Consciousness is a prerequisite for experiencing other welfare consequences and can be caused by ineffective stunning or when animals are allowed to recover after stunning. Unconsciousness should be confirmed by ensuring the presence of signs of unconsciousness or the absence of signs of consciousness:

Indicators – Signs of state of consciousness

Righting reflex: Head righting (attempt to raise head), head shaking after stunning. Ineffectively stunned rabbits and those recovering consciousness will attempt to raise their heads, which is referred to as righting reflex in this opinion, and animals showing this reflex will have to be re-stunned.

Breathing: Effective stunning will result in immediate onset of apnoea (absence of breathing). Ineffectively stunned animals and those recovering consciousness will start to breathe in a pattern commonly referred to as rhythmic breathing, which may begin as gagging and lead to respiratory cycle of inspiration and expiration. Breathing can be recognised from the regular flank and/or mouth and nostrils movement. Recovery of breathing, if not visible through these movements, can be checked by holding a small mirror in front of the nostrils or mouth to look for the appearance of condensation due to expiration of moist air. Immediately after stunning, the absence of breathing (apnoea) will be observed. A rabbit recovering consciousness while hanging on the shackle will attempt to breathe,

which may begin as regular gagging before leading to resumption of breathing. Rabbits showing breathing will have to be re-stunned using a back-up method.

Tonic–clonic seizures: Effective stunning will result in the presence of tonic–clonic seizures. Tonic seizures can be recognised by an arched back and rigidly flexed legs under the body, and will last for several seconds. It is followed by clonic seizures lasting for seconds and manifested as leg kicking or paddling. The absence of tonic–clonic seizures is indicative of consciousness.

Vocalisation: One or repeated short and loud shrieking (squealing) at high frequencies. Vocalisation is expected only in conscious animals and can be used as an indicator in all key stages of monitoring. However, not all conscious animals will vocalise, and hence the absence of vocalisation does not always mean that the animal is unconscious. Animals showing vocalisation must be re-stunned using a back-up method.

Corneal reflex: The corneal reflex is elicited by touching or tapping the cornea. Ineffectively stunned animals and those recovering consciousness will blink in response to the stimulus. Effectively stunned and stuck (bled) animals show the absence of the corneal reflex during any key stage. On the other hand, ineffectively or poorly stunned animals and those recovering consciousness prior to sticking or during bleeding are expected to show the presence of the corneal reflex at any key stage. Animals showing a positive corneal reflex must be re-stunned using a back-up method. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of rabbits may render this indicator invalid.

Palpebral reflex: The palpebral reflex is elicited by touching or tapping a finger on the inner/outer eye canthus or eyelashes. Correctly stunned animals will not show a palpebral reflex. Ineffectively stunned animals and those recovering consciousness will blink in response to the stimulus at any key stage. Animals showing a positive palpebral reflex must be re-stunned using a back-up method. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of rabbits may render this indicator invalid.

Spontaneous blinking: Conscious animals may show spontaneous blinking and therefore this sign can be used to recognise ineffective stunning or recovery of consciousness after stunning. However, not all the conscious animals may show spontaneous blinking. Spontaneous blinking can be used as an indicator at all key stages of monitoring. Animals showing blinking must be re-stunned using a back-up method. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of rabbits may render this indicator invalid.

Immediate collapse: Effective stunning can be recognised from the immediate loss of posture leading to collapse of the animal. Ineffectively stunned animals, on the other hand, will fail to collapse or will attempt to regain posture after collapse. Some ineffectively stunned animals, as may occur, for example, if captive bolt shooting position is wrong or electrically immobilised animals, may lose posture, but remain conscious. The absence of immediate collapse of the animal is indicative of consciousness.

State of death:

Description

According to Council regulation 1099/2009, 'killing' means any intentionally induced process which causes the death of an animal. The purpose of killing methods is to induce death in all animals without requiring bleeding for biosecurity reasons. Nevertheless, bleeding unconscious animals, as a killing method, remains to be an option under certain circumstances. Death should be ensured before animal carcasses are disposed or transported to a rendering place. Death should be confirmed by ensuring the presence of signs of death:

Indicators – Signs of death

Muscle tone: Immediately after killing, dead animals will lose muscle tone, which can be recognised from the completely relaxed legs, floppy ears, and relaxed jaws.

Heart-beat: Onset of death leads to permanent loss of heart beat, which can be ascertained physically by using a stethoscope or by palpation, where possible.

Dilated pupils: Dilated pupils (midriasis) are an indication of death.

Breathing: a dead rabbit is not expected to show any signs of breathing.

Mitigation measures: Any animal showing signs of life should be killed using appropriate back-up methods.

3.7.2. Welfare indicators and their definitions

As mentioned previously, welfare indicators are used to assess the welfare consequences. They are the responses of an animal to a specific input and can be measured directly from the animal or indirectly by using animal records (e.g. number of animals DOA at the slaughterhouse) (EFSA AHAW Panel, 2012a).

Use of some welfare indicators may not be feasible under certain circumstances, for example, rabbits in the middle of a container may not be visible for assessment. In this situation, if existence of the hazard is realised, it should be assumed that the related welfare consequences exist (Table 8).

Table 8: List of welfare indicators with definitions and the welfare consequence/s they are related to. In bracket the references of welfare indicators definition; when references are not available the definition is based on experts' opinion

Welfare indicators	Definition with References	Relevant welfare consequences
Attempts to regain posture	Head righting (attempt to raise head). Head shaking after stunning. Also: righting reflex	Consciousness
Cessation of bleeding	Profuse bleeding from the neck cut wound following neck cutting reduces after a few seconds to minor dripping	Absence of death
Corneal reflex	Blinking response to touching the eyeball (EFSA, 2006)	Consciousness
Dilated pupils	Wide open pupils ('midriasis') (EFSA, 2006)	Death
Facial grimace	Facial expressions related to Orbital tightening, Cheek flattening, Nostril shape, Whisker change and position and Ear shape and position (Keating et al., 2012; Hampshire and Robertson, 2015)	Distress
Escape attempts	Attempts to move or run away from the situation (Trocino et al., 2018)	Fear, pain
Flight	Moving or running away or attempts to do so, often accompanied by vocalisations (see 'escape attempts')	Fear
Gagging or gasping	Rudimentary respiratory activity occurring through mouth (oral breathing) (EFSA, 2006)	Consciousness
Head shaking	Rapid shaking of the head, most times accompanied by stretching and or withdrawal movements of the head	Pain, fear and/or distress
Immediate collapse	The immediate loss of posture leading to collapse of the animal	Consciousness
Injuries	Tissue damage (bruises, scratches, broken bones, dislocations) (EFSA, 2012)	Pain
Muscle tone	Loss of muscle tone can be recognised from the completely relaxed legs, floppy ears and relaxed jaws with protruding tongue	Consciousness
Palpebral reflex	Closing the eyelid following touching or tapping a finger on the inner/outer eye canthus or eyelashes	Consciousness
Righting reflex	Head righting (attempt to raise head), head shaking or after stunning. Also: attempts to regain posture	Consciousness
(Rhythmic) breathing:	Rhythmic breathing recognisable by the regular flank and/or mouth and nostrils movement	Consciousness
Tonic immobility	Attempts to move or run away from the situation. Also 'Escape attempts'	Fear
Tonic–clonic seizures	Tonic seizures can be recognised by an arched back and rigidly flexed legs under the body, and will last for several seconds. It is followed by clonic seizures lasting for seconds and manifested as leg kicking or paddling (EFSA, 2019)	Consciousness
Vocalisation	One or repeated, short and loud shrieking (screaming) at high frequencies (Manteuffel et al., 2004)	Fear, pain

3.8. Response to ToR-3: Identification of preventive and corrective measures

The hazards that potentially appear during on-farm killing can be prevented or corrected by putting in place structural or managerial actions. Preventive and corrective measures refer to the actions that can be implemented to avoid or stop the hazard. In case there is no possible correction for certain hazards, then measures to mitigate welfare consequences linked with the hazards have been described in the text of the opinion (see Section 3.7.1).

In general, according to the mandate, preventive and corrective measures can be grouped into two broad categories:

- 'Structural' measures mean infrastructure or facilities required to minimise or eliminate occurrence of hazards or minimise suffering in rabbits.
- 'Management' measures mean decisions to be made or resources to be put in place by personnel with responsibility or legal obligation for animal welfare.

On the basis of experts' knowledge and when available, considering the literature, for each of the hazards identified, relevant preventive and corrective measures have been listed in the outcome tables, developed by process of the on-farm killing (for details, see Section 3.10, Tables 9–14).

In addition, specific preventive and corrective measures have been developed in association with the relevant hazards' description in section 3.6.

Preventive measures that apply to more than one hazard (e.g. staff training) are described in Section 3.8.1. below, whereas corrective measures, when available, are specific for each hazard (and described in Section 3.6).

In the case of corrective measures, only those that are considered feasible to implement during on-farm killing have been reported.

3.8.1. Preventive measures that apply to multiple hazards

This section lists preventive measures that can be applied to avoid hazards. However, in some situations, the only option to prevent the hazard is to change the method or to try to reduce the consequences of the hazard on the welfare of the rabbits (see mitigation measures to the welfare consequences, Section 3.7.1).

3.8.1.1. Staff training

Description: Training of staff to acquire knowledge and skills required to perform their allocated task efficiently and to let them know that animals are sentient beings that can suffer from pain and fear and therefore should be treated correctly in order to avoid negative welfare consequences. Staff training has been identified as a preventive measure for hazards in all the processes assessed (see Tables 9–14). This shows that even in a well-planned and managed operation, training of staff is a key point to ensure the protection of animals (Humane Slaughter Association, 2017).

For example, all staff involved in the handling of rabbits must be trained as it is the only way to raise awareness of the importance of humane handling. Grandin (1994) showed that the most important aspect which influences how animals are treated is management attitude. Furthermore, the quality of employees and their proper supervision largely determines how many animals are injured, as it has been showed for broiler chicken (Kettlewell and Turner, 1985)

3.8.1.2. Staff rotation

Description: Staff rotation is a management policy in which employees are moved between two or more tasks to avoid boredom and fatigue. Lack of staff rotation is the most important factor that can lead to hazards during killing of rabbits on farm during large-scale killing for disease control purposes (Humane Slaughter Association, 2017). In fact, staff rotation is important to avoid fatigue of workers that can lead to increase a worker's hazard exposure by reducing mental and physical functioning, impairing judgement and concentration, lowering motivation, slowing reaction time, increasing risk-taking behaviour (Guide for Managing The Risk Of Fatigue At Work, Safe Work Australia, 2013). All these factors that can lead to poor rabbit handling practices.

Staff rotation has been identified as an important preventive measure specifically during electrical and mechanical stunning/killing methods due to associated rabbit handling and restraining involved.

3.8.1.3. Slow down the process

Description: Rushing to complete the task of removal of rabbits from barns or cages for the purpose of killing can lead to poor welfare consequences, which can be prevented by slowing down the process.

3.8.1.4. Ensure correct maintenance of the equipment

Description: Design, construction and routine maintenance of equipment is important to ensure good welfare. This applies to all the equipment used for confining, moving and killing rabbits during depopulation actions.

3.8.1.5. Regular calibration and maintenance of the equipment

Description: Electrical killing devices should display the output voltage and amount of current under load. For these displays to be accurate, the electrical killing devices should be regularly calibrated and maintained according to the manufacturer's instruction (AVMA, 2013, 2016). Failing to do so can have severe welfare consequences due to the use of inappropriate parameters leading to ineffective stunning and killing.

3.8.1.6. Adjust equipment accordingly

Description: Electrical parameters used for head-only stunning and killing should lead to effective stunning and killing, the outcome should be routinely monitored and equipment adjusted if necessary (Humane Slaughter Association, 2017).

Failing to achieve effective stunning followed swiftly by a killing method has serious welfare consequences.

3.8.1.7. Proper monitoring of equipment

Description: Proper monitoring and maintenance of equipment is vital to ensure good animal protection during killing on farm. (Humane Slaughter Association, 2017).

3.8.1.8. Ensure equipment is fit for the purpose

Description: Choice of killing device, especially captive bolt gun and associated bolt parameters (diameter, penetration depth, velocity) should be correct for the size of rabbits to render them immediately unconscious leading to death (Humane Slaughter Association, 2017). For example, the power of cartridge, compressed air line pressure or spring should be appropriate for the species and size of rabbits. Cartridges should be stored in a dry place according to the manufacturer's instruction. Operator fatigue and overheating of the gun due to repeated firing in quick succession leads to poor welfare outcomes. There should be sufficient guns such that they are allowed to cool between operations, and they should be cleaned and maintained according to manufacturer's instruction. Similarly, lack of complete severance of brain and spinal cord and/or blood vessels in the neck following mechanical cervical dislocation leads to poor welfare outcomes.

3.8.1.9. Written standard operating procedures in place

Description: Any process used for killing animals on farm should be described in SOPs in order to ensure that animal welfare is protected as much as possible.

There should also be contingency plans to mitigate adverse outcomes (Raj et al., 2006)

3.9. Response to ToR -4: specific hazards for animal categories

The mandate requests to point out specific cases regarding welfare implications. These could include:

- Long-haired breeds (e.g. Angora) may require clipping of hair over the temporal regions to minimise electrical resistance and improve efficacy, especially when using low voltages;
- Some breeds of rabbits have loose skin covering the forehead and extra care needs to be taken while placing captive bolts on their heads to prevent slipping or sliding of the bolt when fired;
- Some large breeds of rabbits (e.g. Flemish Giant) require modifications to stunning equipment;
- Breeds with large/floppy ears require care to prevent pre-stun shocks or mis-stun during captive bolt stunning

- The differences in shape and size of skulls between bucks and does may be more pronounced in some breeds requiring additional attention during stunning.
- Animals reared in different farming systems (Cage versus Park pen) may react differently during handling, restraint and stunning.

3.10. Content of outcome tables linking the aspects requested by the ToRs

Outcome tables were developed and include summarised information linking all the elements analysed to respond to the terms of reference of the opinion – i.e. hazards, welfare consequences, relevant welfare indicators, hazard origins, preventive and corrective actions. The outcome tables are intended as the main result of this scientific opinion with a concise presentation of all retrieved information. Detailed and supporting background information are included in the main chapters of this opinion.

The terminology referred to in the outcome tables is explained in Section 2.2.2.1.

Table 9: Outcome table on '**handling of rabbits**': hazards, with relevant welfare consequences, welfare indicators, origin and preventive and corrective measures

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
People entering the house (see Section 3.6.1.1)	Fear	Staff	All the methods require catching and removal of rabbits from cages	None (Unavoidable as part of the method)	Minimise disturbance
Rough handling of the rabbits (see Section 3.6.1.2)	Pain, fear	Staff, equipment	unskilled personnel; operator fatigue; poorly designed containers or rearing cages (with small openings), too fast operation	Staff training; staff rotation; slow down the process	None
Unexpected loud noise (see Section 3.6.1.3)	Fear	Staff, equipment	Staff shouting, machine noise, killing methods	Identify and eliminate the source of noise; staff training; avoid personnel shouting	None
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	The process of handling implies to manually restraint the rabbits	None (unavoidable as part of the process)	None
Welfare indicators: vocalisations (fear, pain), flight (fear), injuries (pain), escape attempt (fear), tonic immobility (fear)					

Table 10: Outcome table on '**head-only electrical stunning**': hazards, welfare consequences and relevant welfare indicators; hazard origin and preventive and corrective measures

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	Presentation of rabbits to the method is required	None	None
Poor electrical contact (see Section 3.6.1.6)	Consciousness, pain, fear	Staff, equipment	Lack of skilled operators, staff fatigue; incorrect placement of the electrodes; poorly designed and maintained equipment; intermittent contact, thickness of fur	Staff training; staff rotation; ensure correct presentation of the rabbits, ensure correct maintenance of the equipment; ensure the equipment includes electrodes for different sized animals; ensure continuous contact between the electrodes and the rabbits	None
Too short exposure time (see Section 3.6.1.7)	Consciousness, pain, fear	Staff	Lack of skilled operators, too fast operation	Staff training; reduce throughput rate; ensure a timer is built in the stunner to monitor the time of exposure or use of a visual or auditory warning system to alert the operator	None

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Inappropriate electrical parameters (see Section 3.6.1.8)	Consciousness, pain, fear	Staff, equipment	Wrong choice of electrical parameters or equipment; poor or lack of calibration; voltage/current applied is too low; frequency applied is too high for the amount of current delivered; lack of skilled operators, lack of monitoring of stun quality; lack of adjustments to the settings to meet the requirements	Use parameters appropriate to the frequency and waveforms of current; ensure the voltage is sufficient to deliver minimum current; regular calibration and maintenance of the equipment; staff training; consider the factors contributing to high electrical resistance and minimise-eliminate the source of high resistance; monitor stun quality routinely and adjust the equipment accordingly; use constant current source equipment; wetting the head with a damp sponge	None
Prolonged stun-to-kill interval (see Section 3.6.1.9)	Consciousness, pain, fear	Staff	Lack of skilled operators; too long time between stunning and the application of the killing method	Staff training; prompt and accurate killing; reduce stun-to killing interval	None
Welfare indicators: signs of state of consciousness (conscious), injuries (pain), vocalisations (pain, fear), escape attempts (fear, pain, consciousness)					

Table 11: Outcome table on '**captive bolt stunning and killing':** hazards, welfare consequences and relevant welfare indicators; hazard origin and preventive and corrective measures

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	Presentation of rabbits to the method is required	None	None
Incorrect shooting position (see Section 3.6.1.10)	Not dead, consciousness, pain, fear	Staff	Lack of skilled operators, operator fatigue, poor presentation of rabbits, wrong angle of shooting	Staff training and rotation, appropriate restraint of the rabbit	Kill in the correct position
Incorrect bolt parameters (see Section 3.6.1.11)	Not dead, consciousness, pain, fear	Staff, equipment	Lack of skilled operator, wrong choice of equipment, poor maintenance of the equipment, too narrow bolt diameter, shallow penetration, low bolt velocity	Staff training, ensuring equipment is fit for purpose,	None
Welfare indicators: signs of state of consciousness (conscious), signs of death (not dead), injuries (pain), vocalisations (pain fear), escape attempts (fear, pain, consciousness)					

Table 12: Outcome table on '**percussive blow**': hazards, welfare consequences and relevant welfare indicators; hazard origin and preventive and corrective measures

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	Presentation of rabbits to the method is required	None	None
Inversion (see Section 3.6.1.4)	Pain, fear	Staff	Manually inverting the rabbit for the application of the blow	Avoid the inversion of conscious animals	None
Incorrect application (see Section 3.6.1.12)	Not dead, consciousness, pain, fear	Staff	Lack of skilled operator, operator fatigue, poor restraint, hitting in wrong place, insufficient force delivered to the head, wrong choice of tool to deliver the blow	Staff training and rotation, place the head of the rabbit on a hard surface while delivering the blow	Correct application of the method
Welfare indicators: signs of state of consciousness (conscious), signs of death (not dead), injuries (pain), vocalisations (pain, fear), escape attempts (fear, pain, consciousness)					

Table 13: Outcome table on killing with **cervical dislocation'**: hazards, with relevant welfare consequences, welfare indicators, origin and preventive and corrective measures

Hazard	Welfare consequence(s) occurring to the rabbits due to the hazard	Hazard origin(s)	Hazard origin specification	Preventive measure(s) of hazards (implementation of SOP)	Corrective measure(s) of the hazards
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	Presentation of rabbits to the method is required	None	None
Incorrect application (see Section 3.6.1.12)	Not dead, consciousness, pain, fear, distress	Staff, equipment	Lack of skilled operators, operator fatigue, equipment not suitable for size/species of rabbits, attempt to induce cervical dislocation by crushing of the neck rather than by stretching and twisting	• Staff training and rotation; • Use of equipment fit for purpose	None
Welfare indicators: signs of state of consciousness (conscious), signs of death (not dead), vocalisations (pain, fear), escape attempts (fear, pain, consciousness)					

Table 14: Outcome table on killing **with 'lethal injection'**: hazards (with the No. of the section in which hazard's full description is provided), welfare consequences and relevant welfare indicators; hazard's origin and preventive and corrective measures

Hazard	Welfare consequence/s occurring to the rabbits due to the hazard	Hazard origin/s	Hazard origin specification	Preventive measure/s of hazards (implementation of SOP)	Corrective measure/s of the hazards
Manual restraint (see Section 3.6.1.5)	Pain, fear	Staff	Presentation of rabbits to the method is required	None	None
Inappropriate route of administration (see Section 3.6.1.13)	Not dead, consciousness, pain, distress	Staff	Lack of skilled operators, inappropriate restraint, selection of wrong route of administration	Staff training, follow the manufacturer's instructions, use appropriate restraint	Adjust the route of administration
Sublethal dose (see Section 3.6.1.14)	Not dead, consciousness, fear, distress,	Staff	Administration of wrong dose of drug	Staff training, read the manufacturer's instructions to calculate dose appropriate to species/rabbit live weight	Inject with right amount of drug
Welfare indicators: signs of state of consciousness (conscious), signs of death (not dead), vocalisations (pain, fear), escape attempts (fear, pain, consciousness)					

4. Conclusions

4.1. General Conclusions

This scientific opinion focuses on the identification of hazards leading to negative animal welfare consequences during the killing of rabbits for purposes other than slaughter (so called on-farm killing). The hazards, their origins, preventive and corrective measures, welfare consequences and related welfare indicators have been identified based on literature search and expert opinion and considering the common on-farm killing practices. All these elements have been reported in the outcome tables.

The outcome tables summarise the main results of this opinion with a concise presentation of all retrieved information.

Uncertainty in this opinion mainly relates to the possibility of (i) incomplete listing of hazards, namely some welfare related hazards may have been missed in the identification process as considered not existing or not relevant (false negative); and (ii) hazard not relevant for the welfare of rabbits at slaughter being included in the outcome tables (false positive).

The uncertainty analysis on the set of hazards for each process provided in this opinion revealed that the experts were 90–95% certain that they identified all welfare hazards considered in this assessment according to the three criteria described in the Interpretation of ToRs. However, when considering the situation worldwide, there is a 95–99% certainty that at least one welfare hazard is missing.

Similarly, uncertainty exists related to the possibility of incomplete or misclassified listing of hazard origins, preventive, corrective measures, welfare consequences and welfare indicators, but owing to the limited time available to develop this scientific opinion, there is not an uncertainty analysis of this.

1) In total, 14 welfare related hazards have been identified during on-farm killing. Some of these hazards are common to different processes (e.g. inversion) or stunning/killing methods (e.g. manual restraint). Hazards linked to failure in provoking death are the most represented ones.
2) Animal welfare consequences can be the result of single or several hazards. The combination of hazards leads to a cumulative effect on the welfare consequences (e.g. pain due to injury caused by rough handling will lead to more severe pain during manual restraint for electrical stunning).
3) In total, five welfare consequences that can be experienced by rabbits during slaughter have been identified; they are: not dead (after application of killing method), consciousness (after application of killing method), pain, fear and distress.
4) The rabbits will experience the negative welfare consequences only when they are conscious. 'Animals not dead' is considered a welfare consequence after failure of stunning/killing process since animals are subjected to the risk of being disposed (e.g. buried, sent to rendering plant) alive.
5) All the processes described in this opinion have hazards. Regarding the stunning/killing methods, some methods present hazards related to the restraint of rabbits (i.e. electrical and mechanical methods, lethal injection).
6) Some hazards are inherent to the stunning/killing method and cannot be avoided (e.g. manual restraint in electrical stunning), while other hazards originate from sub-optimal application of the method, mainly due to unskilled staff (e.g. rough handling, use of wrong parameters in the case of electrical methods).
7) An adequate monitoring during stunning and killing procedure aiming at avoiding pain, fear and distress, especially during large-scale killing, is considered a pre-requisite to safeguard the welfare of the animals.
8) Lack of staff training is a contributor to most of the hazards.
9) Even if welfare consequences cannot be assessed during on-farm killing, it does not imply they do not exist.
10) Under certain circumstances, not all the welfare indicators can be used to assess the welfare consequences because of low feasibility.
11) For most of the hazards, preventive measures can be put in place, whereas relevant corrective measures are not always available.
12) If not followed by adequate measures correcting the hazard, a welfare consequence will persist until the animal is unconscious or dead.

13) The Panel found no arguments to disagree with the principles given in Chapters 7.5.10 and 7.6 of the OIE Terrestrial code (OIE, 2018) to define methods, procedures or practices that cannot be considered acceptable on welfare grounds. On this basis, examples of methods that should not be used are: killing rabbits by burying, burning, drowning, suffocating, chilling/freezing, the addition of poisons, pesticides or any other toxic substances to feed or water for the purpose of killing.

4.2. Conclusions specific for the processes

4.2.1. Handling

(The specific information can be retrieved in Table 9)

1) Four hazards have been identified in this process. All of them have staff as their origin (ToR-1).
2) Fear is considered the most frequent welfare consequence occurring to rabbits in this process (ToR-2).
3) Preventive measures include staff training aiming at appropriate handling of the rabbits; only one corrective action has been identified (ToR-3).

4.2.2. Electrical methods

This comprises head-only electrical stunning methods (information can be retrieved in Table 10).

1) Five hazards have been identified for these processes. All hazards have staff as their origin and two also include equipment as the origin of the hazard (ToR-1).
2) Head-only electrical stunning does not lead to death; therefore, it needs to be followed by a killing method. (ToR-2).
3) Preventive measures are mainly linked to correct setting of the parameters, and appropriate training and management of the staff and of the equipment in order to reach onset of death for all rabbits, whereas corrective actions do not exist as the hazards are linked to the method (ToR-3)

4.2.3. Mechanical methods

They include captive bolt, percussive blow and cervical dislocation (information can be retrieved in Tables 11–13).

1) Five hazards have been identified for mechanical methods. All of them have staff as origin (ToR-1).
2) Captive bolt and percussive blow are stunning/killing methods for adult rabbits. Three hazards were identified for each of these methods.
3) Cervical dislocation is considered a killing method and therefore it should be only applied on unconscious animals.
4) When properly applied the captive bolt method will kill the rabbit. Nevertheless, death should be confirmed after shooting.
5) Preventive measures (mainly staff training) can be put in place for four of the eight hazards identified in these processes, while no measures have been identified for 'manual restraint' (ToR-3).
6) Corrective measures have been identified only for two of the five hazards, and they are mainly related to the correct application of the method (ToR-3).

4.2.4. Lethal injection

(The specific information can be retrieved in Table 14)

1) Three hazards have been identified for lethal injection. All of them have staff as origin (ToR-1).
2) Preventive measures mainly refer to training of the staff and correct application of the method (ToR-3).

4.2.5. Controlled atmosphere methods

(The method of controlled atmosphere for killing of rabbits has been described in Section 3.4.5 by extrapolation of information related to rabbit slaughter.)

1) Scientific evidence about the procedures for on-farm killing of rabbits with controlled atmosphere methods do not exist and the feasibility of this process cannot be assessed nor the related hazards and welfare consequences.

4.2.6. Methods for killing of kits

(A number of methods for killing kits which were described according to expert knowledge opinion in Section 3.4.6)

1) Scientific literature concerning methods of killing rabbit kits is scarce. Some methods are referred to in legislation or guidance documents, but evidence on killing methods rests predominantly on expert opinion, rather than sound scientific information.
2) In the absence of evidence to the contrary, for humane killing of kits it is suggested to induce unconsciousness by using blunt force trauma immediately followed by either cervical dislocation or decapitation.

5. Recommendations

1) The welfare status of rabbits should be assessed and monitored at each process of on-farm killing (both in large-scale and individual killing) by identifying the existing hazards and assessing the welfare indicators provided in this opinion.
2) If the hazard is present but the use of welfare indicators is not feasible, it should be assumed that the related welfare consequences are experienced by the rabbits.
3) Priority should be given to the implementation of preventive measures. When the rabbit is already exposed to an identified hazard, appropriate corrective measures should be applied (see outcome tables).
4) When no measures to correct the hazard exist, measures to mitigate the welfare consequences should be put in place.
5) All processes of the on-farm killing should be carried out by trained and skilled personnel and also involve proper maintenance and use of adequate stunning/killing equipment.
6) Training of farm staff to acquire skills necessary to perform on-farm killing of rabbits should be implemented.
7) Roles and responsibilities of staff involved in large-scale killing on farm should be clearly identified.
8) The responsible person for killing the animals on-farm should put in place adequate measures to prevent the occurrence of hazards and reduce the associated welfare consequences. Such measures should include: (i) proper procedures (e.g. written SOP, contingency plans), (ii) training and rotation of the staff, (iii) appropriate setting and use of appropriate equipment (see outcome tables).
9) A back-up killing method should be ready at any time to reduce the welfare consequences experienced by the animal and to put the animal to death as soon as possible.
10) Death should be always confirmed at the end of the killing process, before disposing carcasses.
11) If on-farm killing is performed by using a simple (reversible) stunning method (e.g. head-only electrical stunning), a killing procedure should follow (e.g. cervical dislocation).
12) Repeated use of a captive bolt gun in quick succession will lead to overheating of the barrel and failure of the gun. A sufficient number of guns should be made available such that each one can be rested to cool off.
13) Cervical dislocation by crushing should not be used.
14) Cervical dislocation by stretching and twisting of the neck should only be applied to kill unconscious adult rabbits.
15) Lethal injection of anaesthetic drugs should be performed strictly following the manufacturer's instructions with regard to dose, route and rate of administration
16) Poisons/toxins should not be used for on-farm killing.
17) The feasibility of controlled atmosphere method for on-farm killing of rabbits as well as the occurrence of related hazards and welfare consequences needs to be investigated.
18) Ranking of the hazards in terms of severity, magnitude and frequency of the welfare consequences of the rabbits during on-farm killing should be done in order to be able to prioritise actions and improve the procedure of the on-farm killing accordingly.

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Abbreviations

ABM	animal-based measure
AHAW	EFSA Animal Health and Welfare Panel
IP	intraperitoneal
IV	intravenous
LS	literature search

OIE	World Organisation for Animal Health
RHD	rabbit haemorrhagic disease
SOP	standard operating procedure
ToR	Term of Reference
WRSA	World Rabbit Science Association
WG	Working Group

Appendix A – Literature search outcomes

As described in Section 2.2.1, a literature search was carried out to identify peer-reviewed scientific evidence on the topic of 'stunning and killing of rabbits' that could provide information on the elements requested by the ToRs, i.e.: description of the processes, identification of hazards, origins, preventive and corrective measures, welfare consequences and indicators.

To obtain this, first, a broad literature search was carried out, and the results were successively screened and refined as described below.

Sources of information included in the search: Bibliographic database 'Web of Science'.

The search string was designed to retrieve relevant documents to 'animal welfare' during 'slaughter', 'stunning' and 'killing' of 'rabbits'. Restrictions applied in the search string related to the processes under examination and the date of publication (considering only those records published after EFSA, 2005). No language or document type restrictions were applied in the search string.

Table A.1: Date of the search: 19 December 2018

Web of science search string	
Years 2004–2019	
	Category
Search terms	**Field searched**
Rabbit* OR TS=lepor* OR TS=oryctolagus OR TS="oryctolagus cuniculus"	Topic
AND	
TS=slaughter* OR TS=kill* OR TS=stun*	Topic
AND	
TS=Arriv* OR TS=*load* OR TS=lairage* OR TS=handl* OR TS=mov* OR TS=restrain* OR TS=cut* OR TS=bleed* OR TS=conscious* OR TS=pain* OR TS=behav* OR TS=stress*	Topic
Welf* or "animal welfare"	Topic
Results: 53	
Results after screening: 20	

Refinement of literature search results

The search yielded a total of 53 records that were exported to an EndNote library together with the relevant metadata (e.g. title, authors, abstract). Titles and abstracts were first screened to remove irrelevant publications (e.g. related to species, productive systems, processes and research purposes that were out of the scope of this opinion) and duplicates, and successively to identify their relevance to the topic.

Full-text publications were screened if title and abstract did not allow assessing the relevance of a paper. The screening was performed by one reviewer, with support by a second reviewer in cases of doubt; publications that were not considered relevant nor providing any additional value to address the question were also removed. The screening led to nine records relevant to rabbit slaughter, stunning and killing, which are reported in Table A.2. Only one record was considered relevant to the practice of on-farm killing of rabbits (Walsh et al., 2017), whereas the other records were relevant for the description of stunning methods, related hazards and welfare consequences for rabbits.

Table A.2: List of publications relevant to 'slaughter', 'stunning' and 'killing' of rabbits resulting from the literature search

ID	Reference
1	EFSA (2005)
2	EFSA (2006)
3	Dalmau et al. (2016)
4	Llonch et al. (2012)
5	Nakyinsige et al. (2014)
6	Nodari et al. (2009)
7	Trocino et al. (2018)
8	Verga et al. (2009)
9	Walsh et al. (2017)