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Scientific opinion on welfare of dairy cows in relation to udder problems based on a risk assessment with special reference to the impact of housing, feeding, management and genetic selection[1]

Scientific Opinion of the Panel on Animal Health and Animal Welfare

(Question No EFSA-Q-2008-338)

Adopted on 05 June 2009

This opinion, published on 8 October 2009, replaces the earlier version published on 9 July 2009[2].

PANEL MEMBERS

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SUMMARY

Following a request from the European Commission, the AHAW Panel was asked to deliver a Scientific Opinion on the welfare of dairy cows, considering whether current farming and husbandry systems comply with the requirements of and welfare of dairy cows from the pathological, zootechnical, physiological and behavioural points of view.

Due to the great diversity of topics and the huge amount of scientific data, it was proposed that separate scientific opinions on different welfare subjects would be more adequate and effective. Therefore, it was agreed to subdivide the risk assessment process into four different subjects: i) metabolic and reproductive disorders, ii) udder disorders, iii) leg and locomotion problems and iiii) behaviour, fear and pain. A fifth scientific opinion integrates conclusions and

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[2] The above note has been amended to provide the correct title of the opinion. No further changes have been introduced in the opinion or its annexes. To avoid confusion, the original version of the opinion has been removed from the website, but is available on request as is a version showing all the changes made.

recommendations from the scientific report with the outcomes from the four separate risk assessments.

The scientific opinion on welfare of dairy cows in relation to udder problems, based on a risk assessment with special reference to the impact of housing, feeding, management and genetic selection, was adopted by the AHAW Panel on 05 June 2009.

In the risk assessment four different farming scenarios were considered: 1) cubicle houses; 2) tie-stalls; 3) straw yards; 4) pasture. Identified hazards were classified under (a) housing, (b) nutrition and feeding, (c) management and (d) genetics. The risk assessment outcomes for each of these four classes of hazards were determined and the four different farming scenarios compared.

When comparing the different farming systems it can be concluded that the risk of suffering udder problems is independent of the housing system. In the risk assessment, whenever differences between farming systems were present, these were related to the values of risk estimate and magnitude of the adverse effect and not to the ranking of hazards. In addition, it was concluded that housing and management hazards are more likely to cause udder problems that affect welfare, than nutrition-feeding and genetic selection hazards.

According to the scoring system used in this analysis, the most important hazard in relation to the housing was the lack of facilities for cows with systemic mastitis, capable of causing poor welfare due to the increased discomfort, pain and disease duration. The inadequate stall/cubicle design was also very highly ranked, especially in cubicles and tie-stalls. If cubicles are too narrow, movement difficulties and teat trampling may occur. Bedding hygiene is also very important for udder health. Infectious udder disorders may occur more in straw-yards where insufficient attention is given to hygiene of the bedding. If stocking density in straw yards is too high, this may lead to teat trampling. In the risk assessment, the inadequate bedding showed a high magnitude of the adverse effect in all systems but the risk estimate was higher in straw yards, followed by tie-stalls then cubicle housing and very low in pasture.

Hazards related to nutrition and feeding have very low risk probability to cause udder problems without any difference among the farming systems considered.

As regards the management measures for dairy cows, the risk assessment showed that the inadequate treatment and care of animals are the most important hazards for dairy cows. To improve cow welfare, the prevalence of mastitis should be reduced by: the treatment of clinical and subclinical disease, dry cow therapy, identification and elimination of carrier cows, prevention of transmission of infection from cow to cow or through the environment, and improvement of the immune system by minimising stress factors and by a controlled and nutritionally-balanced feed intake. In addition, the inadequate milking procedures (poorly designed or managed milking equipment) lead to teat injury, pain and udder disease in dairy cows. Cow welfare is also poor when stockpersons behave harshly or inconsistently to cows during collection of cows, milking and post milking movement. Robotic milking systems have the potential to improve cow welfare, provided that they are accurately adjusted and carefully supervised, because some cows can select the milking time and the equipment can be accurately adapted to the cow. However, robotic milking systems can be badly managed and some cows may be subjected to long waiting times.

In the risk assessment, genetic selection for high milk yield with insufficient emphasis on other traits relating to fitness showed a relatively low risk of causing udder problems in comparison with some management factors and no differences were observed among the different housing systems analysed. The genetics of mastitis resistance in dairy cattle has been studied for a long period. Most studies have focused on milk somatic cell count or clinical mastitis records as the

phenotypic measure to account for mastitis resistance. Somatic cell count and clinical mastitis have a large genetic component, are genetically correlated, and many data on them are readily available. Mastitis resistance is genetically antagonistic to production traits, and there is increasing economic justification to include the trait in the breeding objectives for the breeds. Therefore many breeding programmes have included somatic cell count, clinical mastitis, or both, in recent decades, as a way to improve resistance to intra-mammary infections.

Key words: animal welfare, dairy cows, udder, mastitis, risk assessment, housing, nutrition and feeding, management, genetic selection, farming systems.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

Council Directive 98/58/EC concerning the protection of animals kept for farming purposes lays down minimum standards for the protection of animals bred or kept for farming purposes, including cattle, although no specific rules are laid down at Community level for dairy cows. The recently adopted Community Action Plan on the Protection and Welfare of Animals has as one of the main areas of action "upgrading existing minimum standards for animal protection and welfare….as well as possibly elaborating specific minimum standards for species or issues that are not currently addressed in EU legislation".

In response to a request from the Commission, EFSA has recently issued a scientific opinion and report on welfare aspects of intensive calf farming systems, updating a report on the welfare of calves adopted by the Scientific Veterinary Committee Animal Welfare Section on 9 November 1995. A scientific opinion on the welfare of cattle kept for beef production was issued by the Scientific Committee on Animal Health and Animal Welfare on 25 April 2001. However no scientific opinion has yet been issued concerning the welfare of dairy cows, except for that on Bovine Somatotrophin (SCAHAW, 1999).

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

Against this background the Commission considers it opportune to request EFSA to issue a scientific opinion on the welfare of dairy cows. This opinion should consider whether current farming and husbandry systems comply with the requirements of the well-being of dairy cows from the pathological, zootechnical, physiological and behavioural points of view. In particular the impact that genetic selection for higher productivity has had on animal welfare should be evaluated, considering inter alia the incidence of lameness, mastitis, metabolic disorders and fertility problems. Where relevant for animal welfare, animal health and food safety aspects should also be taken into account.

Splitting of the Mandate

Due to the great diversity of topics and the huge amount of scientific data, it was proposed that separate scientific opinions on different welfare subjects would be more adequate and effective. The WG Members and the AHAW Panel therefore agreed to initially produce an overall scientific report describing all the hazards identified to be used as a basis for the subsequent risk assessment process which was divided into four different subjects: i) metabolic and reproductive disorders, ii) udder disorders, iii) leg and locomotion problems and iv) behaviour, fear and pain. Since there are some other aspects of poor welfare in dairy cows, in addition to those covered in these four risk assessments, a fifth scientific opinion has also been produced as a global assessment including these aspects. This fifth scientific opinion also integrates conclusions and recommendations from the scientific report with the outcomes from the four separate risk assessments, thus forming an overall summary opinion in response to the mandate.

The list of documents that will be provided to the Commission as a response to the terms of reference of the mandate will be the following:

Scientific Report

"Effects of farming systems on dairy cow welfare and disease"

Scientific Opinion – Udder problems

"Scientific opinion based on a risk assessment of the impact of hazards associated with housing, nutrition and feeding, management and genetic selection on udder problems in dairy cows."

Scientific Opinion - Leg and locomotion problems

"Scientific opinion based on a risk assessment of the impact of hazards associated with housing, nutrition and feeding, management and genetic selection on leg and locomotion problems in dairy cows."

Scientific Opinion - Metabolic and reproductive problems

"Scientific opinion based on a risk assessment of the impact of hazards associated with housing, nutrition and feeding, management and genetic selection on metabolic and reproductive disorders in dairy cows."

Scientific Opinion - Behavioural, fear and pain problems

"Scientific opinion based on a risk assessment of the impact of hazards associated with housing, nutrition and feeding, management and genetic selection on behavioural, fear and pain problems in dairy cows."

Scientific Opinion - Overall

"Overall assessment of the effects of farming systems on dairy cow welfare and disease"

The present scientific opinion will refer only to udder problems in dairy cows.

ACKNOWLEDGEMENTS

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The scientific co-ordination for this Scientific Opinion has been undertaken by the EFSA AHAW Panel Scientific Officers Denise Candiani and Oriol Ribó.

ASSESSMENT

1. Risk Assessment on animal welfare

Animal welfare problems are generally the consequence of negative animal-environment interactions, resulting from animal management factors or housing factors, so called "design criteria" (Anonymous, 2001). The key task of this scientific opinion about the effects of farming systems on the welfare of dairy cows was to find the factors that lead to disease or other causes of poor welfare in dairy cows under current and near future production circumstances. For this purpose a risk assessment was completed.

Presently there are no standards for animal welfare risk assessment. Risk assessment is a systematic, scientifically-based process to estimate the likelihood and severity of a hazard impact and includes four steps: hazard identification; hazard characterisation; exposure assessment; and risk characterisation.

In food risk assessment terminology (Codex Alimentarius, WHO, 1999), a hazard is a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. The risk is a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

Making a parallel to the Codex Alimentarius risk assessment methodology, a hazard in animal welfare risk assessment is a design criterion (usually an environment-based factor) with a potential to cause a negative animal welfare effect, i.e. an adverse effect as measured by one or more welfare indicators.

A risk in animal welfare is a function of the probability of a negative animal welfare effect and the severity of that effect, consequential to the exposure to a hazard(s).

The degree of confidence in the final estimation of risk depends on the variability, uncertainty, and assumptions identified and integrated in the different risk assessment steps.

Uncertainty analysis describes the fact that we have incomplete knowledge. Uncertainty arises in the evaluation and extrapolation of information obtained from epidemiological, experimental, and laboratory animal studies and whenever attempts are made to extrapolate (i.e. to use data concerning the occurrence of certain phenomena obtained under one set of conditions to make estimations or predictions about phenomena likely to occur under other sets of conditions for which data are not available). Uncertainty could be treated formally in conducting more studies or quasi-formally in using expert opinions or informally by making judgment.

Variability is a biological phenomenon (inherent dispersion) and is not reducible. Reduction in variability is not an improvement in knowledge, but instead would reflect a loss of information.

1.1. Steps of the Risk Assessment

For the following steps of the process, the experts were asked to individually fill in a table (see Table 4) for each population (i.e. dairy cows in cubicles, tie-stalls, straw yards and pasture in Europe), based on the available scientific knowledge and data described in the hazard identification section. Most of the data resulted from expert opinion. The values given by the individual expert were compared and discussed within the working group to reach "consensus scores". A formal elicitation process was used to gather consensual values for the parameters.

1.1.1. Definition of the target populations / farming systems scenarios

The first step in the development of the RA was to identify the target populations to be considered. However, the exposure to a specific hazard can be different according to the different farming systems. The working groups decided to make risk assessments for the following four target populations, corresponding to the most relevant systems presently used for keeping dairy cows (cf. chapter 8 of the scientific report):

- dairy cows kept in cubicle houses;
- dairy cows kept in tie-stalls;
- dairy cows kept in straw yards;
- dairy cows kept at pasture.

The above mentioned systems were defined and considered as follows:

Cubicle house: this is a loose-housing system where cows are kept either for half a year (180 days) or a full year (365 days) in the cubicle house. In some farms they may be able to go outside either always or occasionally to a yard or to pasture for a short or long period.

Tie-stall: cows kept tied up and milked either in their stall or in a milking parlour. In some farms they may be able to go outside either always or occasionally to a yard or to pasture for a short or long period.

Straw yard: this is a loose-housing system with a straw bed as the lying area. A partial concrete floor area behind the feeding fence may be available and the milking system is usually the same as in cubicle houses. Cows are kept in the system either for half a year or a full year. In some farms they may be able to go outside either always or occasionally to a yard or to pasture for a short or long period.

Pasture: cows kept on pasture; the grazing period is considered on half a year basis (180 days). For the other half of the year the cows are kept in one of the other systems. Cows are supposed to be outside full time when on pasture, except for milking. That holds for conditions of health control and calving or feed supplementation.

The way in which these systems are implemented varies among countries in Europe, depending on geographical factors such as climate and soil type, availability of resources, traditions, and market circumstances. In addition, they can also vary substantially among farmers within countries and regions. As it is difficult to consider in the RA all possible systems and situations at EU level, a European average has been considered for the scoring of the RA tables.

1.1.2. Hazard identification

The aim of this step is to identify hazards, i.e. causes or factors that negatively affect the animal's welfare. If animal needs are not met, hazards may occur with consequent adverse effects. In this step, the scientific evidence of association between the exposure to a given production factor (hazard) and the consequent impact on animal welfare are reviewed. Once the target populations were defined, a list of hazards with their adverse effects affecting each of the populations was agreed upon. The hazards were identified in relation to the needs of the animals, as described in Chapter 7 of the Report, in order that no hazards would be omitted. One example is to consider the need to drink, the hazard of difficult access to water and the adverse effects of thirst, dehydration and perhaps anxiety. Another example is the need to rest and exercise, the hazard of slippery floors and the adverse effect of lameness, pain and malaise (Candiani et al., 2007).

For each population, a table was made listing all identified hazards with their adverse effects. If for the same hazard different adverse effects occur, a line for each considered adverse effect was listed.

1.1.3. Hazard Characterisation

The objective of this step is to review and describe the consequences of the exposure to one or several hazards in terms of magnitude and likelihood of the adverse effect for the individual animal. The magnitude of the adverse effect is the product of its severity and duration.

The severity of the adverse effect was scored subjectively by the members of the working group based on the available scientific information about the level of physiological and behavioural responses. Severity scores ranged on a 5 points scale from negligible (score 0) to very severe (score 4). See Table 1 for the severity scores.

Table 1. Severity scores of the adverse effects.

Evaluation	Score	Explanation
Negligible	0	No pain, malaise, frustration, fear or anxiety as evidenced by a range of behavioural, physiological and clinical measures.
Mild	1	Minor changes from normality indicative of pain, malaise, fear or anxiety.
Moderate	2	Moderate changes from normality indicative of pain, malaise, fear or anxiety. Clear change in adrenal or behavioural reactions, such as motor responses and vocalisations.
Severe	3	Substantial changes from normality indicative of pain, malaise, fear or anxiety. Strong change in adrenal or behavioural reactions, such as motor responses and vocalisations.
Very severe	4	Extreme changes from normality indicative of pain, malaise, fear or anxiety, usually in several measures, that could be life-threatening if they persist.

The duration of the effect was expressed as the number of days per year where a cow was believed or expected to be experiencing the adverse effect, once it would be exposed to the hazard. The assessments were always performed on a 1 year basis (365 days).

The magnitude of the adverse effect represents the potential animal welfare adverse effect at the individual level, given that the animal is exposed to the hazard and experiences that adverse effect. For the final estimation of the magnitude of the adverse effect, the severity score was adjusted in order to give even weighting to the scores. Therefore, the magnitude of the adverse effect was calculated as follows:

Magnitude of the adverse effect = (Severity score/4) * Duration of the effect

The experts were also asked to score the quantitative assessment of likelihood that an adverse effect can occur for a given exposure to a hazard. The expert opinion was modelled using a Beta-Pert distribution that requires three parameters, namely minimum, most likely and maximum. The three parameters range from 0 to 100% (see example in Table 4).

The qualitative assessment of Uncertainty for each assessment according with the availability of any scientific evidence was also scored, in agreement with the definition given in Table 2.

Table 2. Qualitative uncertainty scores.

Low	Solid and complete data available; strong evidence provided in multiple refs; authors report similar conclusions.
Medium	Some but no complete data available; evidence provided in small number of refs; authors' conclusions vary from one to another. Solid and complete data available from other species which can be extrapolated to the species considered.
High	Scarce or no data available; rather evidence provided in unpublished reports, based on observations or personal communications; authors' conclusions vary considerably between them.

1.1.4. Exposure assessment

The assessment of the exposure is the quantitative assessment of the probability of the specific scenario of exposure. The different exposure scenarios were defined by the experts. The scenario takes into account the intensity and duration of an exposure to one or several hazards during the considered period of the animal's life, namely one year, as previously reported (see hazard characterization).

The duration (in days on a 1 year basis) of the exposure to the hazard was agreed by the WG for each target population as follows:

- when the term transition period is used it was considered as 30 days and lactation period was considered as 305 days as it includes the transition period.
- when the hazard was judged to be present only in half a year the duration was calculated as 180 days (for instance in autumn-winter when the cows are housed rather than at pasture).
- when the hazard was judged to be present in half a year plus part of the following season, the duration was considered as 200 days;
- when the hazard was judged to be present only during the two months with more extreme temperatures (i.e. July/August or January/February), the duration was considered to be 60 days;
- other durations were estimated on a case by case basis.

The Intensity of exposure to a hazard is measured either as full exposure/no exposure or exposure to a given range of intensity of the hazard (ammonia concentration example). If there are different levels of exposure, one line was created for each level. This is relevant when data on the frequencies of the different level of exposures and data on the relationship between the level of exposure and the severity and likelihood of the consequences (adverse effect) are available.

The likelihood of each exposure scenario (quantitative assessment of likelihood of exposure) for a defined target population was assessed by the experts and then modelled using a Beta-Pert distribution (as before three parameters minimum, most likely and maximum, ranging from 0 to 100% are required). The uncertainty score (see Table 2) for each assessment, was estimated as for the hazard characterization.

The example in Table 3 shows a cow through one year of her life, exposed to an inappropriate water temperature (too low - < 5 °C or too high - > 25 °C) during 2 months per year (60 days), and which, as a consequence of this exposure, suffers from different metabolic and reproductive disorders a respiratory disease of a limited severity during 2 days per year.

Table 3. Example of a consensus. Table for scoring the hazards.

Target population: dairy cows													
Hazard description	**Hazard characterisation**							**Exposure assessment**					
	Adverse effect [b]	**Severity of the adverse effect** [c]	**Duration of the adverse effect (%) d**	**Likelihood of the adverse effect (%)** [e]			**Uncertainty** [f]	**Duration (%)** [g]	**Intensity** [h]	**Likelihood of the exposure to the hazard (%)** [i]			**Uncertainty**[j]
				min	**ml**	**max**				**min**	**ml**	**max**	
Inappropriate temperature of drinking water (too high or too low)	dehydration, reduced feed intake, ketosis, SARA, reproductive failure	1- Limited	2	5	10	15	Medium	60	< 5 C or > 25 C	10	20	30	H

Table 3 Legend:

a = Name of the **Target population**.
b = **Adverse effect** in relation to the needs and consequence of not fulfilling the needs.
c = **Severity** of the adverse effect. Classification based on the criteria in Table 2.
d = **Duration** of the adverse effect given the indicated exposure, during one year.
e = Quantitative assessment of **Likelihood of the adverse effect**: minimum (**min**), most likely (**ml**) and maximum (**max**).
f = **Qualitative Assessment of the Uncertainty**, based on data available for the quantitative assessment (Table 3).
g = **Duration** of the exposure relative to the life time: value from 0% to 100%.
h = **Intensity** of exposure to a hazard, measured either as full exposure/no exposure or exposure to a given range of intensity of the hazard. If there are different levels of exposure, one line was created for each level.
i = Quantitative assessment of **Likelihood of Exposure to the hazard**: minimum (**min**), most likely (**ml**) and maximum (**max**).
j = **Qualitative Assessment of the Uncertainty**, based on data available for the quantitative assessment (Table 3).

1.1.5. Risk Characterisation

Risk characterisation uses hazard characterisation and exposure assessment scores to calculate a risk estimate score expressing the extent of risk of animals in the population exposed to a given hazard.

It aims to give information to the risk manager to evaluate a specific situation regarding the fulfilling of animal needs and maximising good welfare.

Once all the scores were agreed and the consensus tables completed, the risk estimates were calculated for each hazard as follows:

Risk estimate = (Severity score/4) * (Duration of the effect) * (Likelihood of the adverse effect) * (Likelihood of exposure to the hazard)

This formula assumes the following:

- that there is linearity on the severity scores (e.g. 2 days suffering from an intensity score 2 is equivalent to 1 day suffering from an intensity score 4).

- that there is no interaction between hazards.
- that the hazards are mutually exclusive.

Because the previous assumptions are extremely tentative and could not be verified within the scope the WG's mandate, the risk calculation has to be interpreted with extreme caution. A simple interpretation is to consider the risk calculation as the number of days the animals are suffering from poor welfare induced by the exposure to the considered hazard.

To assess the effect of an exposure to several hazards, summation is avoided by precaution, as the different exposures are not mutually exclusive and it is needed to weight the different outcomes before summation.

The risk calculation mainly serves the purpose of ranking the importance of the different considered hazards within the examined populations.

The risk estimate distribution was calculated using a stochastic simulation model. This runs for 20 000 iterations using Monte-Carlo sampling method with @Risk (Palisade, Ithaca, USA) add-in for Microsoft Excel®. The risk output distribution was described using its median, 5th and 95th percentiles.

The qualitative assessment of the uncertainty on the risk output was derived accordingly to a classification matrix (Table 4) used for the calculation of the product of both the uncertainty evaluations, namely the one related to the likelihood and the one related to the exposure.

Table 4. Classification matrix of the qualitative assessment of the uncertainty.

Adverse effect uncertainty \ Exposure uncertainty	High	Medium	Low
High	High	High	High
Medium	High	Medium	Medium
Low	High	Medium	Low

1.2. Graphical presentation of the Risk Characterisation

The consensus Tables in the Appendix 3 are divided in three sections: Hazard Characterisation (HC), Exposure Assessment (EA) and Risk Characterisation. HC and EA sections include all values agreed by the experts and used to calculate the Risk Characterisation for each hazard listed in the consensus Tables. The Risk estimate (CI 90%) values are reported by the median and the 5th and 95th percentiles (error bars). This distribution takes into account the uncertainty on the measurement used for the estimation.

In the Appendix, for each hazard category within each production system, values of the risk estimate (median, 5th and 95th percentiles) and values of the magnitude of the adverse effect are presented as a histogram. The magnitude of the adverse effect represents the potential animal welfare adverse effect at the individual level, given that the animal is exposed to the hazard and experiences that adverse effect. The risk estimate is an indicator at the population level, considering not only the likelihood of the animals of that population being exposed to a given hazard, but also the likelihood of the animals to experience an adverse welfare effect if they are exposed.

Both values are given because this will allow risk managers to analyse the RA outcomes according to either the risk that the hazards impose or the magnitude of the adverse effects. A

separate graph has been created for each hazard category within each production system and hazards in the graphs have been ordered by decreasing risk estimate value.

1.2.1. Notes to the reader

1) The same hazard may be repeated two or more times, the reason being that hazards may have different adverse effects on animal welfare depending on the duration or intensity of exposure by the animal. Therefore, if for the same hazard different levels of intensity were defined, the hazard was repeated in order to analyze the different intensities separately. Similarly, if for the same hazard different adverse effects can occur, the hazard was repeated and each considered effect was listed.
2) Any difference in the Exposure Assessment between the tables in the different scientific opinions is related to the different hazard specifications.
3) c. Running numbers in the first column of the Tables cross reference the hazards in the chart.
4) d. Conclusions including aspects related to more than one specific subject (e.g. behaviour problems but also leg problems) have been incorporated into the scientific opinion on "Leg and locomotion problems in dairy cows" and are not repeated here.
5) e. The conclusions presented here below have been extrapolated from the outcomes of the risk assessment process and combined with the conclusions obtained from the data presented in the Scientific Report. They are listed in relation to the contents of the Scientific Report. When a conclusion comes from the Risk Assessment it is explicitly stated.
6) d. The risk assessment outcomes should be interpreted in relation to the level of uncertainty associated with each single risk estimate and to the magnitude of the adverse effects. On the other hand, high uncertainty levels may only concern part of the assessment (hazard characterization or exposure assessment) and do not necessarily imply that the risk estimate is incorrect. High uncertainty is often an indicator of a necessity for research or further data collection.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions presented here below have been extrapolated from the outcomes of the risk assessment process and combined with the conclusions obtained from the data presented in the Scientific Report. They are listed in relation to the contents of the Scientific Report. When a conclusion comes from the risk assessment it is explicitly stated.

Conclusions including aspects related to more than one specific subject (e.g. udder problems but also leg problems) have been incorporated into the scientific opinion on "Leg and locomotion problems in dairy cows" and are not repeated here.

A general conclusion from the risk assessment was that the presence of udder problems in relation to the hazards considered is independent of the farming systems. Differences between farming systems, whenever present, are related to the values of risk estimate and magnitude of the adverse effect and not to the ranking of hazards. In addition, housing and management hazards are more likely to cause udder problems that affect welfare, than nutrition-feeding and genetic selection hazards.

The major welfare problems are associated with mastitis and it is recognised that their occurrence is also related to other factors than are covered in this risk assessment.

Chapter 4 - Genetic change for higher productivity and disease resistance in dairy cattle in relation to welfare

- From the **risk assessment** it was concluded that hazards related to genetic selection, primarily for high milk production, show a relatively low risk of causing udder problems in comparison with other factors. No differences have been observed among the different housing systems analysed.

4.2.2. Mastitis

Conclusions

- The genetics of mastitis resistance in dairy cattle has been studied for a long period. Most studies have focused on milk somatic cell count or clinical mastitis records as the phenotypic measure to account for mastitis resistance. Somatic cell count and clinical mastitis have a large genetic component, are genetically correlated, and many data on them are readily available.
- Mastitis resistance is genetically antagonistic to high milk production traits, and there is increasing economic justification to include the trait in the breeding objectives for the breeds. Therefore many breeding programmes have included somatic cell count, clinical mastitis, or both, in recent decades, as a way to reduce the incidence of mastitis.

Chapter 5 - Nutrition and major metabolic disorders in relation to welfare

- The **risk assessment** showed that nutrition and feeding hazards have very low risk probability to cause udder problems without any difference among the farming systems considered.

Chapter 6 - Housing conditions in relation to welfare

6.1. Building design

Conclusions

- If cubicles are too narrow, movement difficulties and teat trampling may occur.

- The **risk assessment** showed that the inadequate stall design has a very high magnitude of the adverse effect if the hazard is present in cubicles and tie-stalls.
- The **risk assessment** showed that lack of facilities for taking care of cows with systemic mastitis is one of the highest ranked hazards, capable of causing poor welfare due to the increased discomfort, pain and disease duration. The values for risk estimate and magnitude of the adverse effect are similar in all farming systems.
- The **risk assessment** highlighted that stall design and bedding (quantity and quality) should be such as to reduce the probability of intra-mammary infection and udder trauma.

6.7. Bedding

Conclusions

- Udder infections may occur more in straw-yards where insufficient attention is given to hygiene of the bedding. If stocking density in straw yards is too high, this may lead to teat-trampling.
- Bedding hygiene is important for udder health in all systems.
- The **risk assessment** showed that the inadequate bedding has a high magnitude of the adverse effect in all systems but the risk is higher in straw yards, followed by tie-stalls then cubicle housing and very low in pasture.

6.11. Use and exposure to electric shocks

Conclusions

- The use of electric cow trainers can improve the cleanliness of the keeping area and the animals but the risk of hock lesions increases and their use has been found to be associated with increased incidence of mastitis, ketosis and silent heat.

Chapter 7 - Milking procedures in relation to welfare

7.3.2. Milking process

Conclusions

- Poorly designed, constructed or managed milking equipment leads to teat injury, pain and udder disease in dairy cows.
- Cow welfare is poor when stockpersons behave harshly or inconsistently to cows during collection of cows, milking and post milking movement.
- Inappropriate cleaning, disinfection and drying of udders increase the risk of transmission of pathogens.
- The **risk assessment** showed that inadequate milking procedures are an important hazard in all systems.

Recommendations:

- The maintenance of milking equipment and all milking procedures should be carried out in accordance with relevant guidelines.
- Milking equipment should be designed, constructed, managed, cleaned and disinfected so that to the risk of injury, pain and disease in dairy cows is minimised.

- Milking equipment should be checked and maintained at least once every six months.
- Cleaning of udders should take full account of the risk of transmission of pathogens.
- The persons who are milking cows should behave calmly and consistently towards cows during collection of cows, milking and post milking movement.
- Waiting times in collecting or milking areas before milking for each cow should be short and never more than one hour.
- The **risk assessment** highlighted that milking procedures should comply with relevant guidelines for the prevention of mastitis.

7.3.3. Cow traffic

Conclusions

- Robotic milking systems have the potential to improve cow welfare, provided that they are accurately adjusted and carefully supervised, because some cows can select the milking time and the equipment can be accurately adapted to the cow. However, robotic milking systems can be badly managed and some cows may be subjected to long waiting times.
- If food and water are restricted to encourage cows to visit the milking robot, they may be deprived, frustrated or subjected to long standing times.
- On some farms where robotic milking systems are used, cows may not be inspected sufficiently frequently for the adequate detection of welfare problems.

Recommendations

- Cows should be allowed to have access to food and water independent of visiting the milking robot, except for initial training purposes.
- The design of robot milking systems should not restrict the cow's access to a sufficient amount of a balanced diet. During the grazing season this may include access to pasture.
- Robotic milking systems should be carefully adjusted and checked each day.
- All cows on a robotic milking system should be inspected twice per day.

Chapter 8 - Social and maternal behaviour in relation to management and welfare

Conclusions

- Udder health may be improved by restricted suckling (i.e. twice/day).
- The **risk assessment** showed that poor calving conditions (poor hygiene and limited space) has a low risk estimate, due to a low frequency, in all systems. When the hazard is present it may cause major udder problems (high magnitude of the adverse effect).

Chapter 10 - Mastitis and welfare

10.2. Incidence and prevalence of mastitis

Conclusions

- Clinical mastitis is a painful condition in dairy cows but there are levels of sub-clinical mastitis that have only a small effect on welfare. The somatic cell count and clinical

inspection are the most common methods of monitoring sub-clinical and clinical mastitis.

- Mastitis is a major welfare problem in dairy cows and it reduces the income of the farmer. Some farmers fail to implement an adequate programme for the prevention and control of mastitis.

Recommendations

- Pain management should be part of the treatment of clinical mastitis.

10.3. Pathology, pathogenesis and treatment (and next sections)

Conclusions

- Factors affecting the incidence of mastitis include pathogens, genetic predisposition, management quality and social factors in the herd.
- Management quality includes maintaining bedding, milking machine maintenance, milking technique and hygiene.
- Mastitis reduction, and hence better welfare, results from i) treatment of the disease (clinical or subclinical form), ii) dry cow therapy, iii) identification and elimination of carrier cows, iv) prevention of transmission of infection (from cow to cow or through the environment) and v) improvement of the immune system (by minimising social, physical or pathological stress factors and by a controlled and nutritionally balanced feed intake).

Recommendations

- In order to reduce udder infections, a full programme of control measures should be implemented. For example, cleaning of milking equipment should be performed adequately by chemical, thermal and physical processes. The environment of the cow should be clean, dry and well ventilated.
- To improve cow welfare, the prevalence of mastitis should be reduced by: the treatment of clinical and subclinical disease, dry cow therapy, identification and elimination of carrier cows, prevention of transmission of infection from cow to cow or through the environment, and improvement of the immune system by minimising stress factors and by a controlled and nutritionally-balanced feed intake.

Chapter 13 - Handling in relation to welfare

- From the **risk assessment** it was concluded that there are no major differences in the ranking of all hazards among the four farming systems, except for some of the low-ranked hazards.

13.2. On farm monitoring

Conclusions

- The risk assessment showed that hazards related to treatment and care of animals (i.e. inadequate antimicrobial treatments, inappropriate care of animals by stockperson) are the highest ranked in all farming systems. In cubicle houses, straw yards and pasture, the five highest ranked hazards are the same with same risk probability values and

magnitude of the adverse effect. In the case of tie-stalls, the risk probability of inadequate antimicrobial treatments is lower than in the other three systems.

Recommendations

- The **risk assessment** highlighted that appropriate care of animals with systemic mastitis should include separation to adequate facilities with good bedding and management of toxaemia and pain. Veterinary advice should be sought. Also, antimicrobial treatments should be judicious so as to be effective as well as to reduce the possibility of bacterial resistance.

13.4. Animal identification and mutilations

- The docking of the tails of cattle causes pain when it is carried out without use of anaesthetic or analgesic, can lead to prolonged pain from neuromas, has a serious adverse effect on the ability of the animal to deal with flies and may lead to greater risk of disease such as summer mastitis.

13.8. Pain management – surgery, disease, trauma etc.

Conclusions

- Pain management is possible for a wide range of conditions and operations in cows.

Recommendations

- Pain management should be carried out in dairy cattle in such a way as to combine the reduction of pain and the prevention of possible hyperalgesia.
- The **risk assessment** highlighted that pain management should be part of treatment of cows with acute mastitis.

DOCUMENTATION PROVIDED TO EFSA

No documents were provided to EFSA by the European Commission.

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APPENDICES

APPENDIX A

RISK ASSESSMENT TABLES AND FIGURES

The following appendix reports the risk assessment tables that were compiled and scored by the Working Group. The subsequent graphs, where hazards are ranked by their risk estimate values, correspond to the outcomes of the risk assessment.

CUBICLE HOUSES			UDDER PROBLEMS																
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
12.3	**8**	**Lack of facilities for sick animals**	cows with systemic mastitis	pain, trauma, discomfort	3	10	40	50	60	M	365	full exposure	50	70	90	H	2.625	7.5	H
12.3	**9**	**Lack of facilities for sick animals**	increased infection pressure to remaining population at risk	Localised Mastitis	2	3	2	5	8	H	365	full exposure	50	70	90	H	0.053	1.5	H
6.2	**10**	**Fewer cubicles than cows**	reduced udder cleanliness	Systemic Mastitis and trauma	3	10	20	25	30	H	365	>10% overstocking	1	2	3	H	0.038	7.5	H
13.1	**11**	**Inadequate or lack of handling/restraining facilities**	_	Trauma, pain	3	3	1	2	3	H	10	full exposure	30	50	70	H	0.023	2.25	H
7.2/ 7.3/ 10.8	**12**	**Inadequate maintenance of milking equipment**		Localised Mastitis and teat disorders	2	3	10	30	50	L	60	full exposure	20	30	40	H	0.135	1.5	H
6.5	**13**	**Inappropriate temperature, humidity THI>78**	increased infection pressure	Mastitis (3)	3	5	5	10	15	M	5	THI>78	10	15	20	H	0.056	3.75	H
8.2 / 10.8	**14**	**Poor calving conditions**	poor hygiene and limited space	Systemic Mastitis and trauma (1)	3	10	10	20	30	M	7	full exposure	15	25	35	H	0.375	7.5	H

Figure 1 Risk assessment: hazards related to housing in dairy cows kept in cubicle house.

CUBICLE HOUSES				UDDER PROBLEMS																
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
6.5	1	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Systemic Mastitis (1)	3	5	2	5	8	M	60	<60 m3 air/500 kg LW	5	10	15	M	0.01875	3.75	M
6.5	2	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Localised Mastitis (2)	2	3	1	2	3	H	60	<60 m3 air/500 kg LW	5	10	15	M	0.003	1.5	H
6.5	3	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Systemic Mastitis (1)	3	5	4	7	10	M	200	<60 m3 air/500 kg LW	5	10	15	M	0.02625	3.75	M
6.5	4	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Localised Mastitis (2)	2	3	2	4	6	H	200	<60 m3 air/500 kg LW	5	10	15	M	0.006	1.5	H
6.1	5	**Poor cubicle design**		Systemic Mastitis and trauma including teat problems	3	10	7	10	13	L	365	full exposure	40	70	90	L	0.525	7.5	L
6.7 / 10.8	6	**Inadequate bedding**	hygiene, composition and quantity	Systemic Mastitis and trauma including teat problems	3	10	10	15	20	L	365	full exposure	30	50	70	M	0.563	7.5	M
6.2	7	**Lack of space, e.g. for exercising, social interactions and resting**	teat trampling injury	Mastitis (3)	2	3	1	3	5	H	365	full exposure	40	60	80	H	0.027	1.5	H

Figure 1. Risk assessment: hazard related to housing in dairy cows kept in cubicle house (continued).

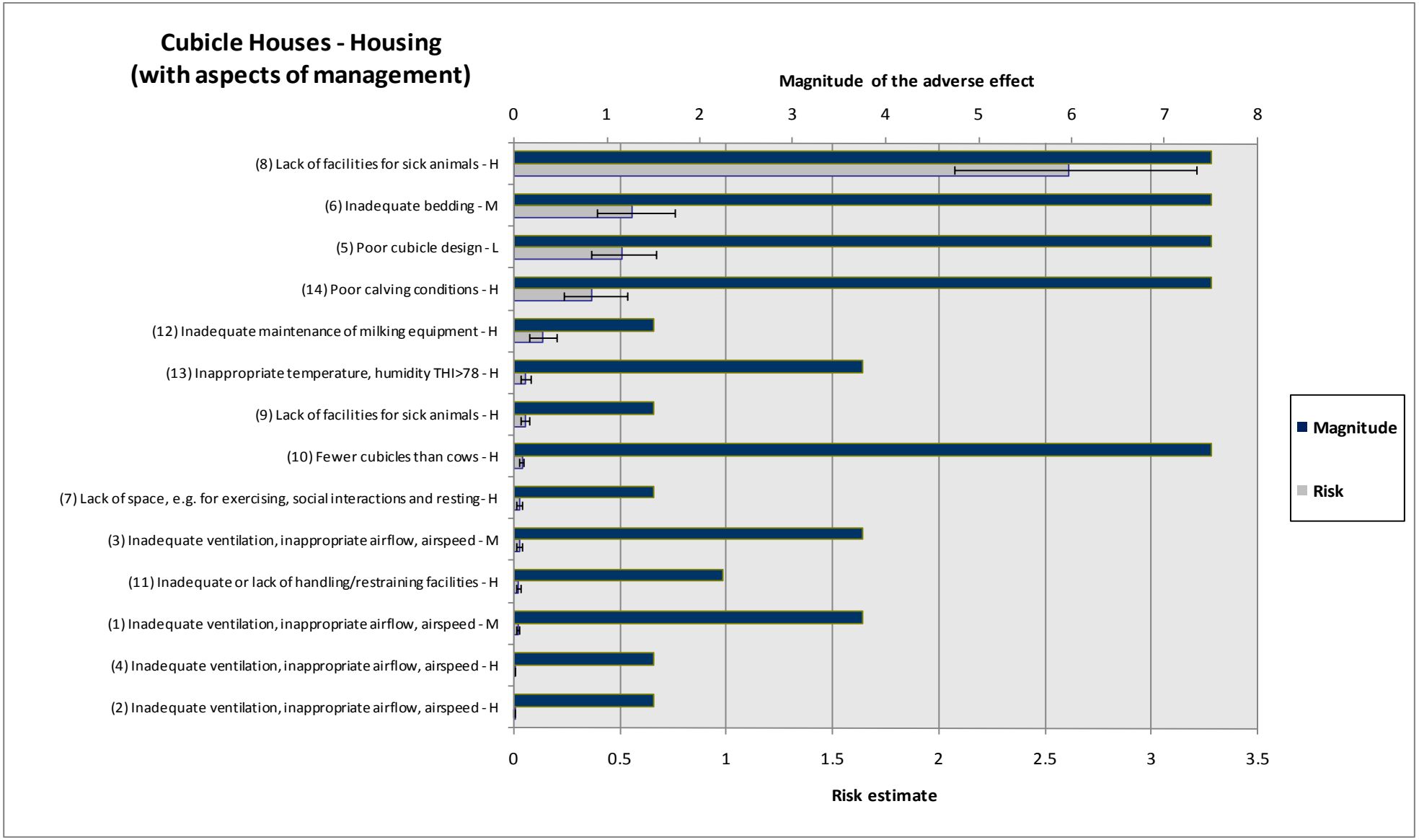

Figure 2. Ranking of hazards related to housing in dairy cows kept in cubicle houses.

CUBICLE HOUSES UDDER PROBLEMS																				
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
NUTRITION AND FEEDING																			
5.1 / 10.8	**1**	**Improper ration composition**	Inadequate protein/ carbohydrate ratio and peNDF <20% of dry matter leading to metabolic disorders	Mastitis (3)	2	3	10	20	30	L	90	rumen pH < 5.8 more than 3 hours	10	15	20	M	0.045	1.5	M
5.1 / 10.8	**2**	**Improper ration composition**	Inadequate vitamine (vit. E) and mineral (Se) supply	Mastitis (3)	2	3	5	10	15	L	305	rumen pH < 5.8 more than 3 hours	15	20	25	H	0.030	1.5	H

Figure 3. Risk assessment: hazards related to nutrition and feeding in dairy cows kept in cubicle houses.

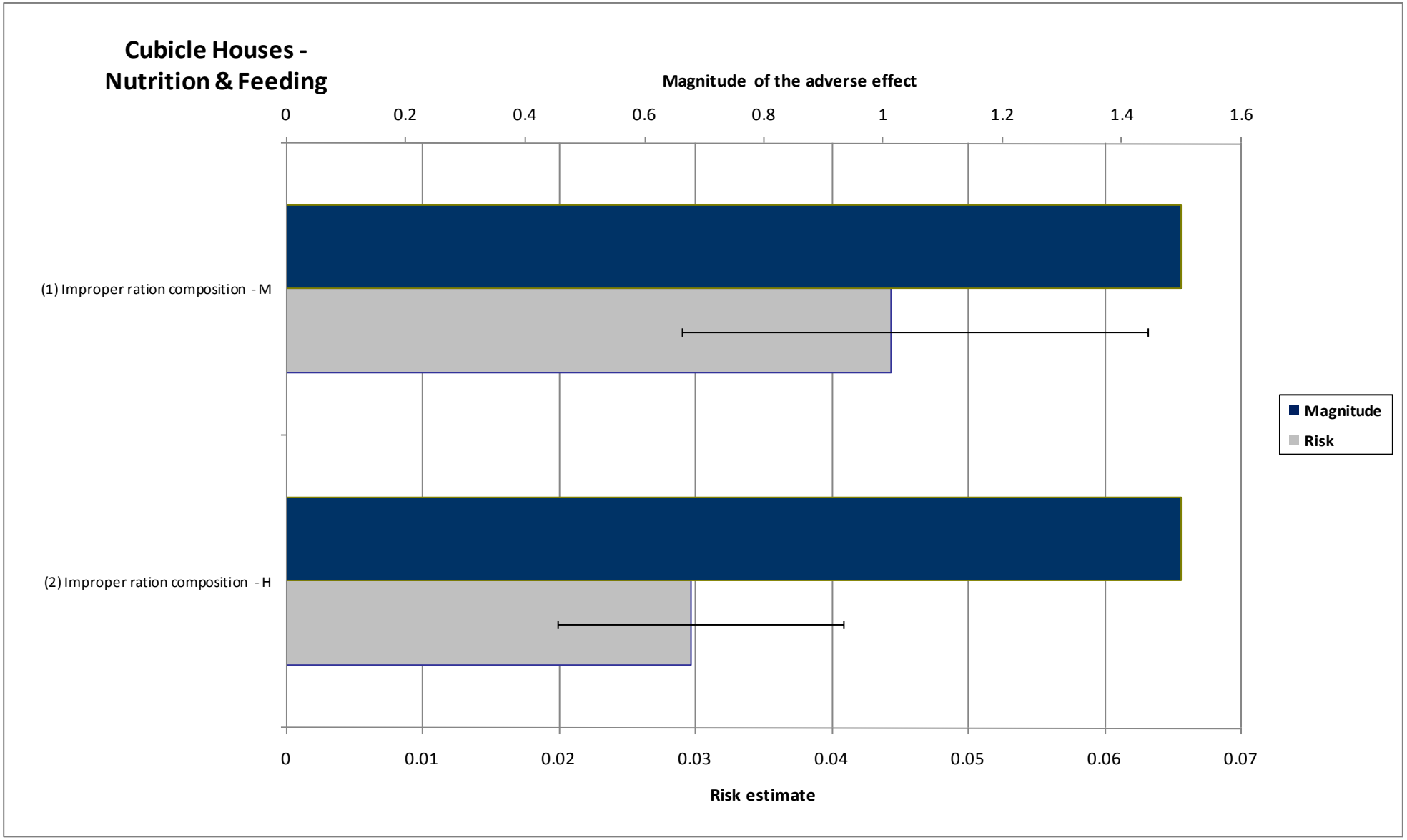

Figure 4. Ranking of hazards related to nutrition and feeding in dairy cows kept in cubicle houses.

CUBICLE HOUSES			UDDER PROBLEMS																
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
8.2. / 8.3 / 8.4	**1**	**Poor calving management**	separation, isolation, immunosupression	Systemic Mastitis (1)	3	5	1	5	10	M	5	full exposure	10	20	30	H	0.038	3.75	H
10.5 / 10.8 / 10.9 / 14	**2**	**Insufficient or inappropriate care of animals by stockperson**	delayed detection of mastitis due to negligence /lack of knowledge	Increased duration or severity of Mastitis (3)	3	10	50	60	70	L	365	full exposure	20	30	40	H	1.350	7.5	H
7.2 / 7.3 / 10.8 / 14	**3**	**Inadequate milking procedures**	dipping, milking time, incomplete milking, teat cleaning, blind milking, cleaning and disinfection, separate milking of sick animals	Contagious mastitis (4) and teat disorders	2	5	50	60	70	L	305	full exposure	30	50	70	H	0.750	2.5	H
10.3 / 10.8/13.2	**4**	**Inadequate antimicrobial treatments**	lack of veterinary diagnosis and supervision, treatment too short	Increased duration or severity leading to chronic mastitis	3	10	40	50	60	L	365	full exposure	40	60	80	H	2.250	7.5	H
13.8	**5**	**Inadequate analgesic treatments**	non treating for pain of a systemic Mastitis	Prolongued pain and discomfort	4	10	80	90	100	L	5	full exposure	5	10	15	H	0.900	10	H
10.4	**6**	**Inadequate treatments of other diseases**	_	Mastitis and teat trauma	3	5	5	10	15	M	40	full exposure	20	30	40	H	0.113	3.75	H

Figure 5. Risk assessment: hazards related to management in dairy cows kept in cubicle houses.

CUBICLE HOUSES				UDDER PROBLEMS															
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
12.3	7	**Inadequate biosecurity**	introducing infections e.g. cattle with Mastitis	Mastitis (3)	3	3	30	40	50	L	365	full exposure	50	70	90	H	0.630	2.25	H
12.3	8	**Inadequate biosecurity**	introducing infections e.g. diseased cattle, BVD, IBR, BT…	Mastitis (3)	3	5	1	5	10	M	365	full exposure	50	70	90	H	0.131	3.75	H
12,3	9	**Inadequate biosecurity**	inadequate control of pest and vectors	Contagious Mastitis (4) i.e. summer mastitis	2	10	2	5	7	L	100	full exposure	30	50	70	H	0.125	5	H
10.5/ 10.7 10.8 / 10.9 / 14	10	**Inadequate clinical health monitoring and prevention**	including recording and planning of mastitis	Mastitis (3)	3	5	10	20	30	M	365	full exposure	30	40	50	H	0.300	3.75	H
13.7	11	**Downer cow**	Improper management of downer cows - Lack of: physiotherapy, good bedding, proper facilities and lifting devices	Systemic mastitis and teat trauma	4	5	98	99	100	L	15	full exposure	0.5	1	1.5	M	0.050	5	M
13.4	12	**Keeping cows with horns**	Increased agression, trauma and stress	Mastitis and udder trauma	3	10	5	10	15	M	365	full exposure	1	3	5	M	0.023	7.5	M

Figure 5. Risk assessment: hazards related to management in dairy cows kept in cubicle houses (continued).

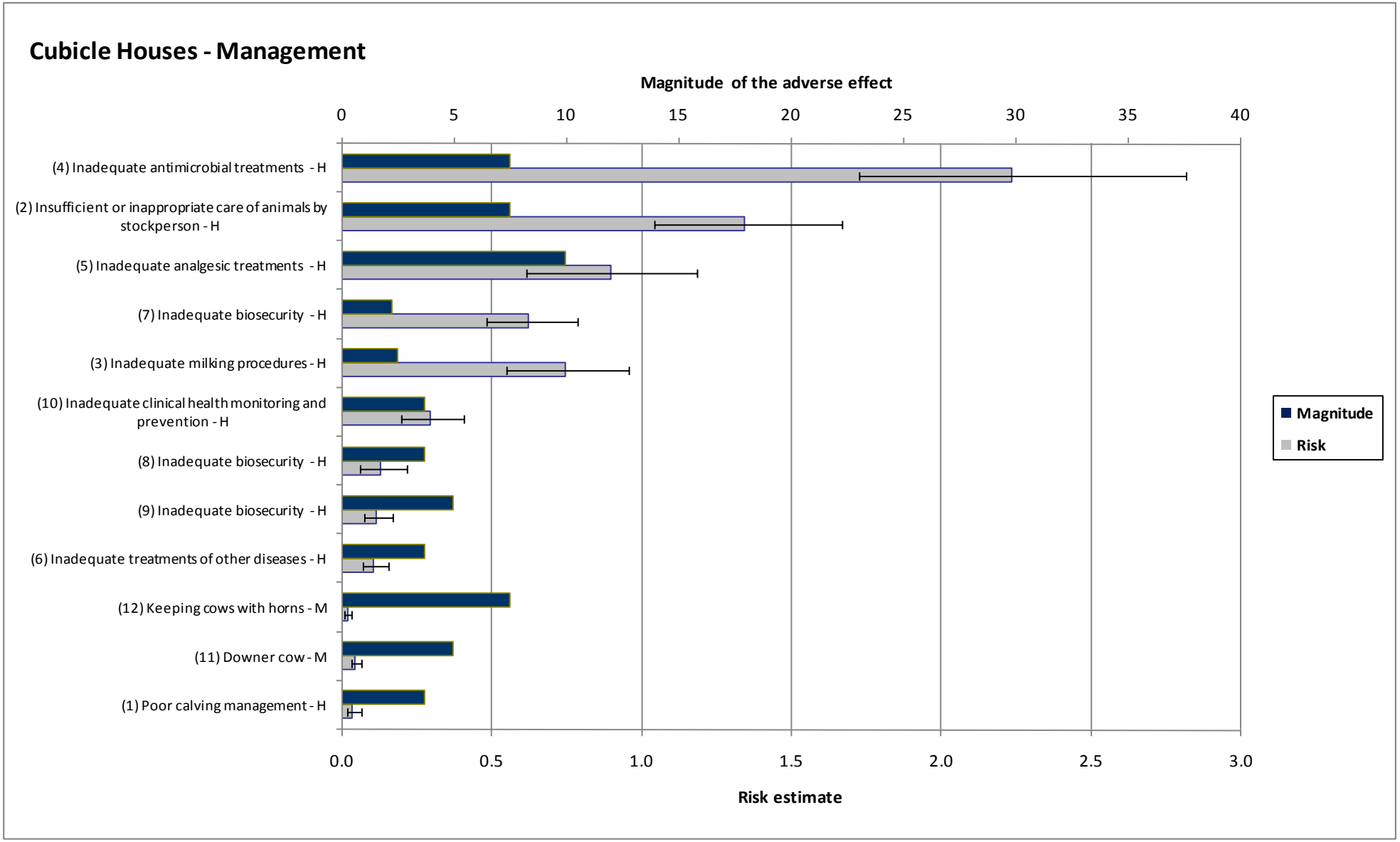

Figure 6. Ranking of hazards related to management in dairy cows kept in cubicle houses.

CUBICLE HOUSES				UDDER PROBLEMS																
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
GENETICS																			
4.2	**1**	**high genetic potential for production due to selection ignoring other traits**	with good housing, nutrition and management	Mastitis (3)	2	5	20	30	40	L	365	estimated breeding value for yield in top quartile for breed and country	20	30	40	H	0.225	2.5	H
4.2	**2**	**high genetic potential for production due to selection ignoring other traits**	without good housing, nutrition and management	Mastitis (3)	3	10	40	50	60	M	365	estimated breeding value for yield in top quartile for breed and country	30	40	50	H	1.500	7.5	H

Figure 7. Risk assessment: hazards related to genetics in dairy cows kept in cubicle houses.

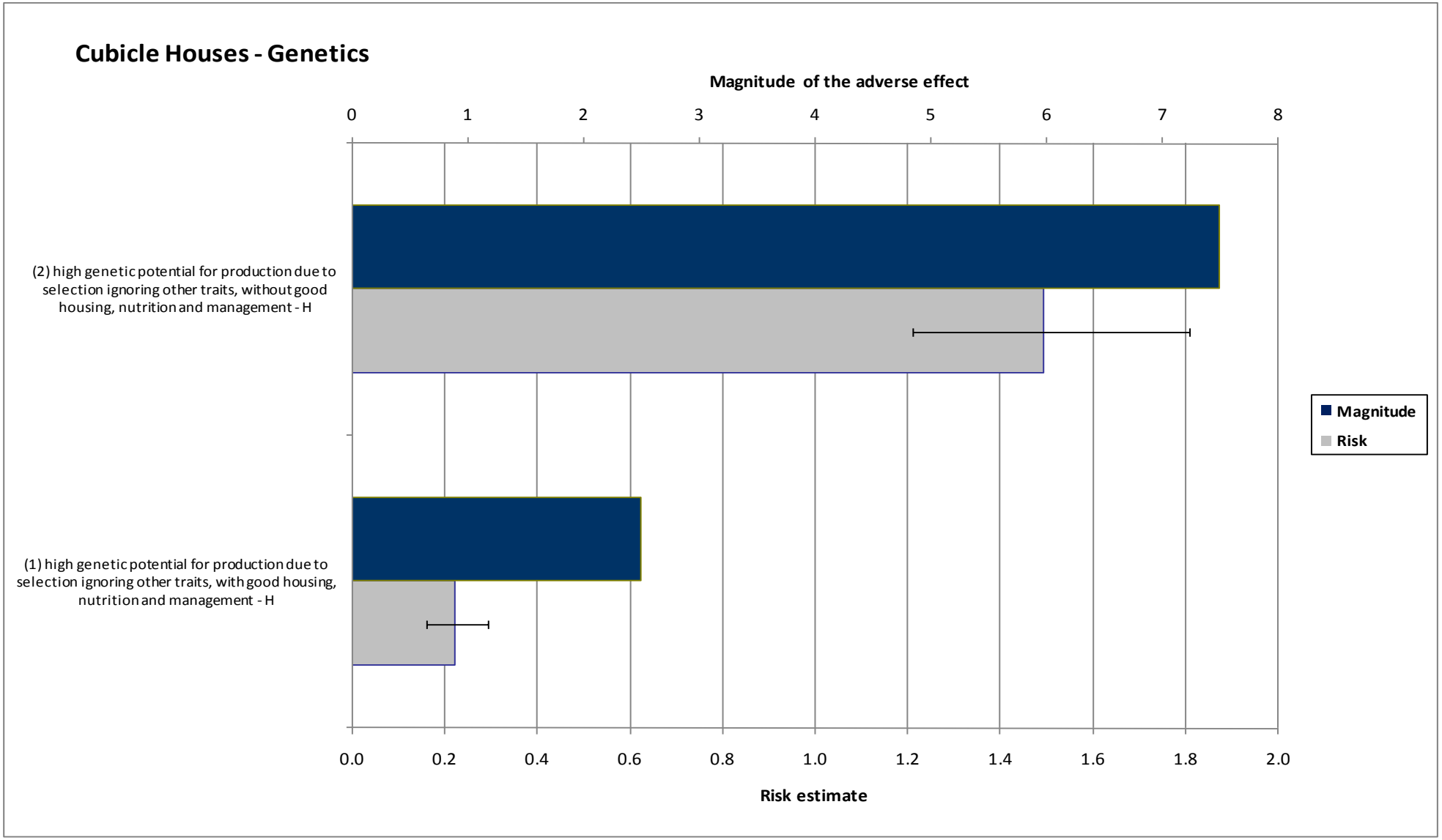

Figure 8. Ranking of hazards related to genetics in dairy cows kept in cubicle houses.

TIE- STALLS				UDDER PROBLEMS															
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
6.5	1	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Systemic Mastitis (1)	3	5	2	5	8	M	60	<60 m3 air/500 kg LW	5	10	15	M	0.019	3.75	M
6.5	2	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Localised Mastitis (2)	2	3	1	2	3	H	60	<60 m3 air/500 kg LW	5	10	15	M	0.003	1.5	H
6.5	3	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Systemic Mastitis (1)	3	5	4	7	10	M	200	<60 m3 air/500 kg LW	5	10	15	M	0.026	3.75	M
6.5	4	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Localised Mastitis (2)	2	3	2	4	6	H	200	<60 m3 air/500 kg LW	5	10	15	M	0.006	1.5	H
6.1	5	**Poor stall design**	_	Systemic Mastitis and trauma including teat problems	3	10	10	15	20	L	365	full exposure	40	70	90	L	0.788	7.5	L
6.7/ 10.8	6	**Inadequate bedding**	hygiene, composition and quantity	Systemic Mastitis and trauma including teat problems	3	10	10	15	20	L	365	full exposure	30	40	50	M	0.450	7.5	M

Figure 9. Risk assessment: hazards related to housing in dairy cows kept in tie-stalls.

TIE- STALLS				UDDER PROBLEMS															
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
6.2	7	**Lack of space, e.g. for exercising, social interactions and resting**	teat trampling injury	Localised Mastitis (2)	2	3	1	3	5	H	365	full exposure	60	80	100	H	0.036	1.5	H
12.3	8	**Lack of facilities for sick animals**	cows with Systemic mastitis	pain, trauma, discomfort	3	10	20	25	30	M	365	full exposure	50	70	90	H	1.313	7.5	H
12.3	9	**Lack of facilities for sick animals**	increased infection pressure to remaining population at risk	Localised Mastitis	2	3	1	3	5	H	365	full exposure	50	70	90	H	0.032	1.5	H
13.1	10	**Inadequate or lack of handling/restraining facilities**	_	Trauma, pain	3	3	1	2	3	H	10	full exposure	15	30	45	H	0.014	2.25	H
7.2 / 7.3 / 10.8	11	**Inadequate maintenance of milking equipment**	_	Localised Mastitis and teat disorders	2	3	10	30	50	L	60	full exposure	20	30	40	H	0.135	1.5	H
6.5	12	**Inappropriate temperature, humidity THI>78**	increased infection pressure	Mastitis (3)	3	5	5	10	15	M	5	THI>78	20	30	40	H	0.113	3.75	H
8.2 / 10.8	13	**Poor calving conditions**	poor hygiene and limited space	Systemic Mastitis and trauma (1)	3	10	10	20	30	M	7	full exposure	15	25	35	H	0.375	7.5	H

Figure 9. Risk assessment: hazards related to housing in dairy cows kept in tie-stalls (continued).

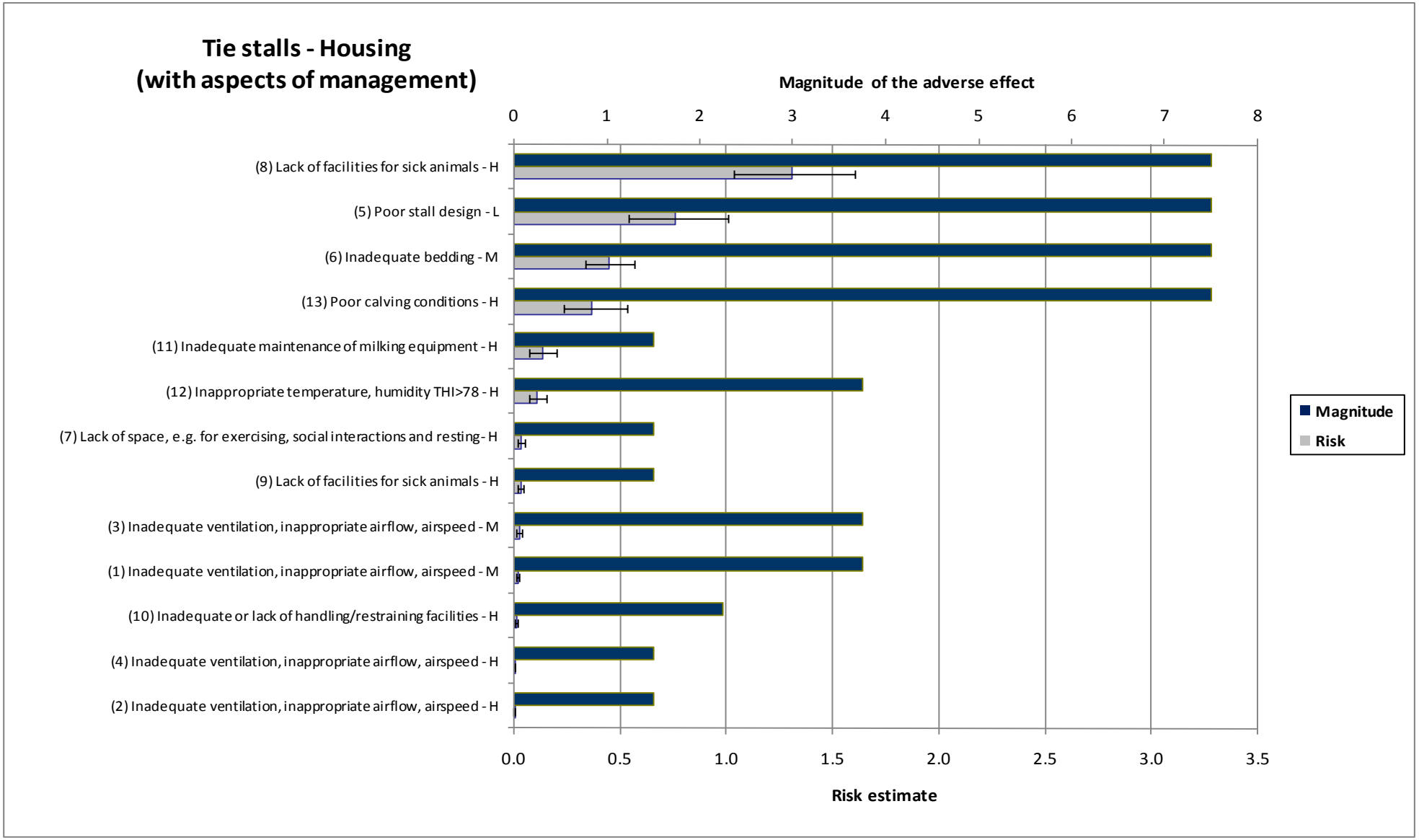

Figure 10. Ranking of hazards related to housing in dairy cows kept in tie-stalls.

TIE- STALLS UDDER PROBLEMS																				
Referred chapter of the scientific report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
		Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
NUTRITION AND FEEDING																			
15.1 / 10.8	1	**Improper ration composition**	Inadequate protein/ carbohydrate ratio and peNDF <20% of dry matter leading to metabolic disorders	Mastitis (3)	2	3	10	20	30	L	90	rumen pH < 5.8 more than 3 hours	10	15	20	M	0.045	1.5	M
5.1 / 10.8	2	**Improper ration composition**	Inadequate vitamine (vit. E) and mineral (Se) supply	Mastitis (3)	2	3	5	10	15	L	305	rumen pH < 5.8 more than 3 hours	15	20	25	H	0.030	1.5	H

Figure 11. Risk assessment: hazards related to nutrition and feeding in dairy cows kept in tie-stalls.

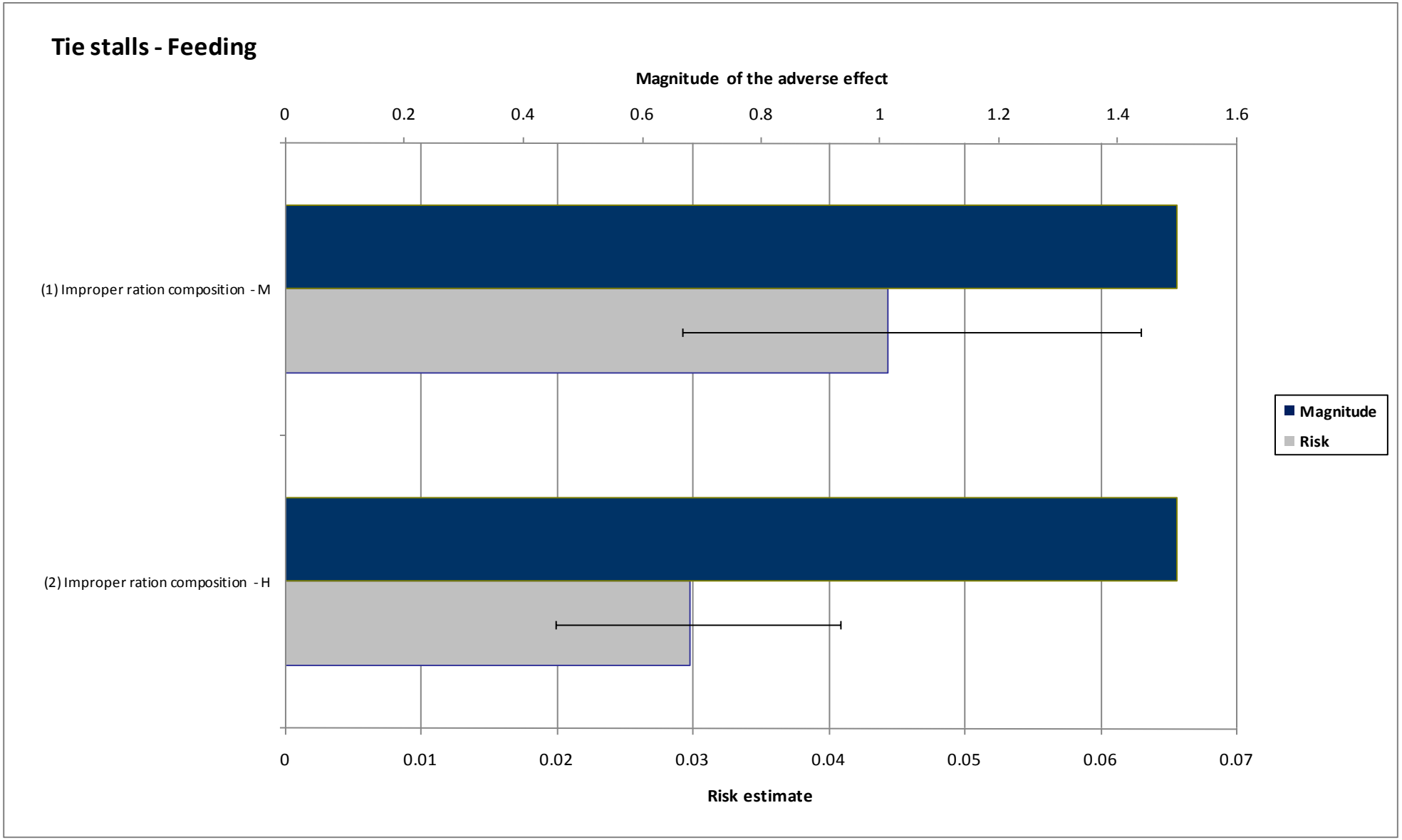

Figure 12. Ranking of hazards related to nutrition and feeding in dairy cows kept in tie-stalls.

TIE- STALLS				UDDER PROBLEMS																
Referred chapter of the scientific report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization			
		Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
8.2. / 8.3 / 8.4	**1**	**Poor calving management**	separation, isolation, immunosupression	Systemic Mastitis (1)	3	5	1	5	10	M	5	full exposure	10	20	30	H	0.038	3.75	H
10.5 / 10.8 / 10.9 / 14	**2**	**Insufficient or inappropriate care of animals by stockperson**	delayed detection of mastitis due to negligence /lack of knowledge	Increased duration or severity of Mastitis (3)	3	10	50	60	70	L	365	full exposure	20	30	40	H	1.350	7.5	H
7.2 / 7.3 / 10.8 / 13.1	**3**	**Inadequate milking procedures**	dipping, milking time, incomplete milking, teat cleaning, blind milking, cleaning and disinfection, separate milking of sick animals	Contagious mastitis and teat disorders	2	5	50	60	70	L	305	full exposure	30	50	70	H	0.750	2.5	H
10.3 / 10.8/13.2	**4**	**Inadequate antimicrobial treatments**	lack of veterinary diagnosis and supervision, treatment too short	Increased duration or severity leading to chronic mastitis	3	10	40	50	60	L	365	full exposure	40	60	80	H	2.250	7.5	H
13.8	**5**	**Inadequate analgesic treatments**	non treating for pain of a systemic Mastitis	Prolongued pain and discomfort	4	10	80	90	100	L	5	full exposure	5	10	15	H	0.900	10	H
10.4	**6**	**Inadequate treatments of other diseases**	_	Mastitis and teat trauma	3	5	5	10	15	M	40	full exposure	20	30	40	H	0.113	3.75	H

Figure 13. Risk assessment: hazards related to management in dairy cows kept in tie-stalls.

TIE- STALLS				UDDER PROBLEMS																
Referred chapter of the scientific report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
		Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
12.3	7	**Inadequate biosecurity**	introducing infections e.g. cattle with Mastitis	Mastitis (3)	3	3	30	40	50	L	365	full exposure	50	70	90	H	0.630	2.25	H
12.3	8	**Inadequate biosecurity**	introducing infections e.g. diseased cattle, BVD, IBR, BT…	Mastitis (3)	3	5	1	5	10	M	365	full exposure	50	70	90	H	0.131	3.75	H
12.3	9	**Inadequate biosecurity**	inadequate control of pest and vectors	Contagious Mastitis (4) i.e. summer mastitis	2	10	2	5	7	L	100	full exposure	30	50	70	H	0.125	5	H
10.5 / 10.8 / 10.9 / 14	10	**Inadequate clinical health monitoring and prevention**	including recording and planning of mastitis	Mastitis (3)	3	5	10	20	30	M	365	full exposure	30	40	50	H	0.300	3.75	H
13.7	11	**Downer cow**	Improper management of downer cows - Lack of: physiotherapy, good bedding, proper facilities and lifting devices	Systemic mastitis and teat trauma	4	5	98	99	100	L	15	full exposure	0.5	1	1.5	M	0.050	5	M

Figure 13. Risk assessment: hazards related to management in dairy cows kept in tie-stalls (continued).

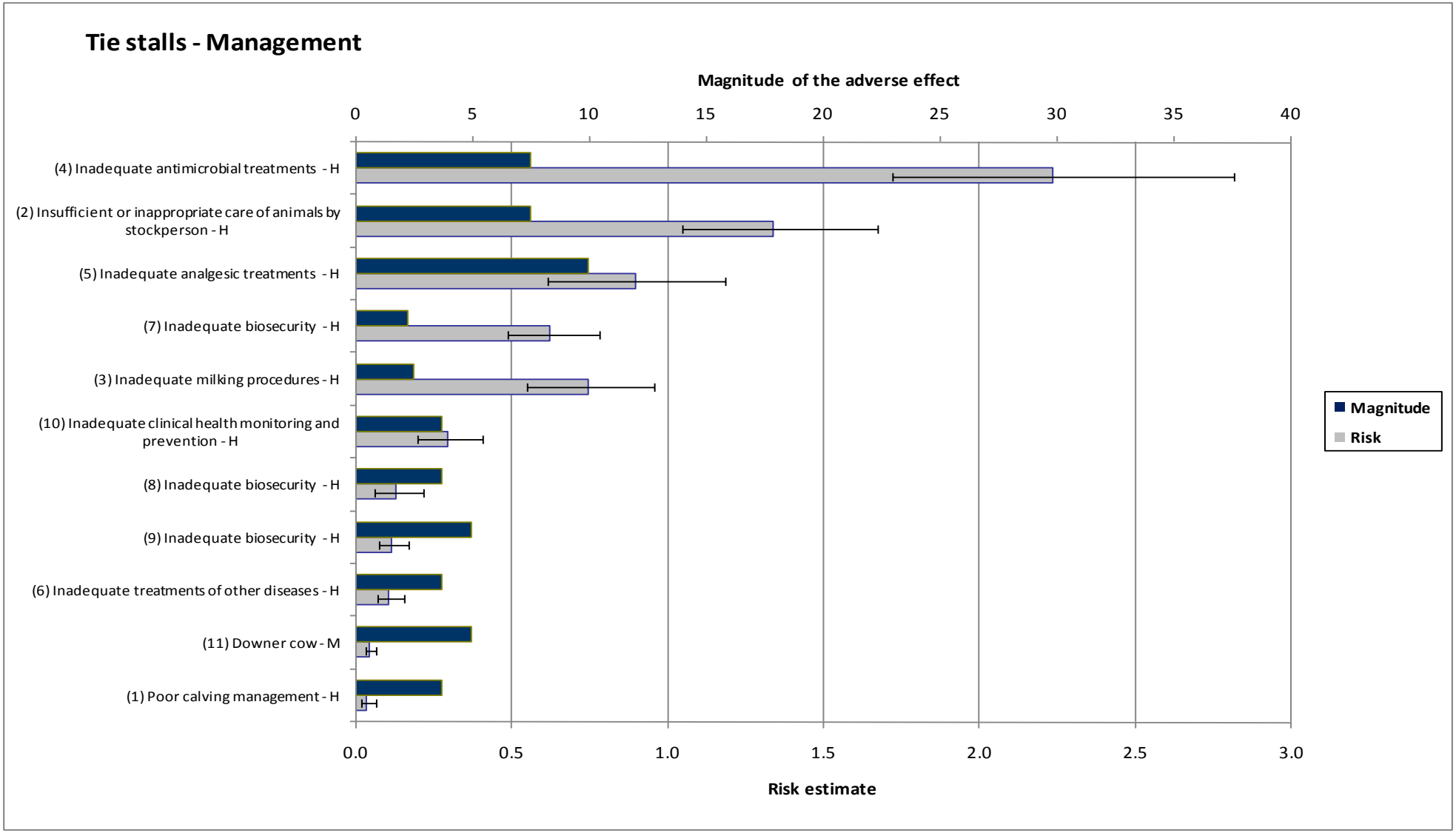

Figure 14. Ranking of hazards related to management in dairy cows kept in tie-stalls.

TIE- STALLS				UDDER PROBLEMS																	
Referred chapter of the scientific report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization				
		Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty		
							min	ml	max				min	ml	max						
GENETICS																					
4.2	1	**high genetic potential for production due to selection ignoring other traits**	with good housing, nutrition and management	Mastitis (3)	2	5	10	20	30	L	365	estimated breeding value for yield in top quartile for breed and country	20	30	40	H	0.150	2.5	H		
4.2	2	**high genetic potential for production due to selection ignoring other traits**	without good housing, nutrition and management	Mastitis (3)	3	10	30	40	50	M	365	estimated breeding value for yield in top quartile for breed and country	30	40	50	H	1.200	7.5	H		

Figure 15. Risk assessment: hazards related to genetics in dairy cows kept in tie-stalls.

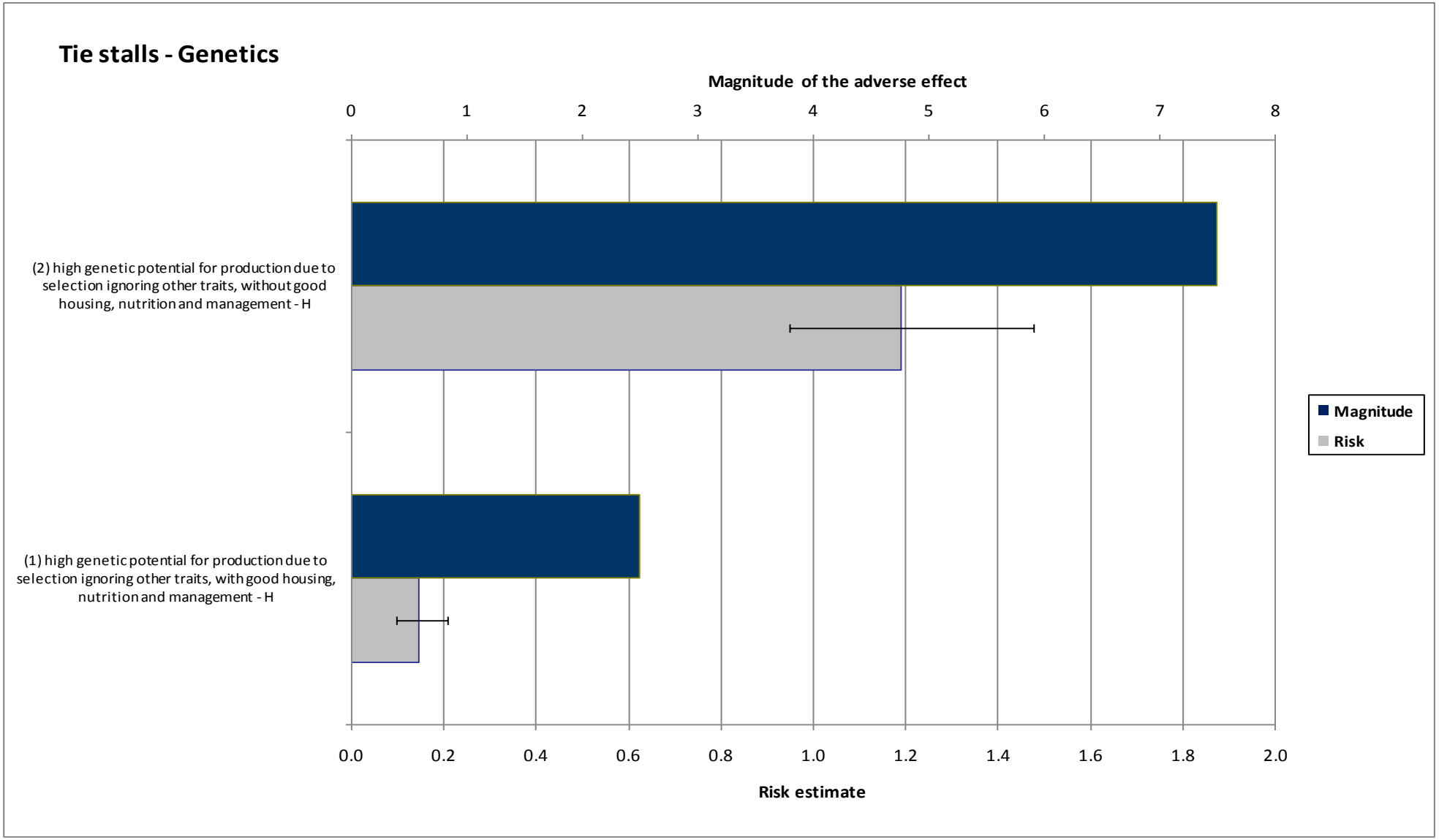

Figure 26. Ranking of hazards related to genetics in dairy cows kept in tie-stalls.

STRAW YARDS				UDDER PROBLEMS															
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
6.5.	1	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Systemic Mastitis (1)	3	5	2	5	8	M	60	<60 m3 air/500 kg LW	5	10	15	M	0.019	3.75	M
6.5.	2	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of winter period)	Localised Mastitis (2)	2	3	1	2	3	H	60	<60 m3 air/500 kg LW	5	10	15	M	0.003	1.5	H
6.5.	3	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Systemic Mastitis (1)	3	5	4	7	10	M	200	<60 m3 air/500 kg LW	5	10	15	M	0.026	3.75	M
6.5.	4	**Inadequate ventilation, inappropriate airflow, airspeed**	too low ventilation (1/3 of indoor period + part of summer)	Localised Mastitis (2)	2	3	2	4	6	H	200	<60 m3 air/500 kg LW	5	10	15	M	0.006	1.5	H
6.7 / 10.8	5	**Inadequate bedding**	hygiene, composition and quantity	Systemic Mastitis and trauma including teat problems	3	10	20	30	40	L	365	full exposure	30	50	70	M	1.125	7.5	M
6.2	6	**Lack of space, e.g. for exercising, social interactions and resting**	teat trampling injury	Localised Mastitis (2)	2	3	1	3	5	H	365	full exposure	20	30	40	H	0.014	1.5	H

Figure 17. Risk assessment hazards: related to housing in dairy cows kept in straw yards.

STRAW YARDS				UDDER PROBLEMS															
Hazard identification				Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
12.3	7	**Lack of facilities for sick animals**	cows with Systemic mastitis	pain, trauma, discomfort	3	10	40	50	60	M	365	full exposure	50	70	90	H	2.625	7.5	H
12.3	8	**Lack of facilities for sick animals**	increased infection pressure to remaining population at risk	Localised Mastitis	2	3	2	5	8	H	365	full exposure	50	70	90	H	0.053	1.5	H
13.1	9	**Inadequate or lack of handling/restraining facilities**	--	Trauma, pain	3	3	1	2	3	H	10	full exposure	30	50	70	H	0.023	2.25	H
7.2 / 7.3 / 10.8	10	**Inadequate maintenance of milking equipment**	--	Localised Mastitis and teat disorders	2	3	10	30	50	L	60	full exposure	20	30	40	H	0.135	1.5	H
6.5	11	**Inappropriate temperature, humidity THI>78**	increased infection pressure	Mastitis (3)	3	5	5	10	15	M	5	THI>78	10	15	20	H	0.056	3.75	H
8.2 / 10.8	12	**Poor calving conditions**	poor hygiene and limited space	Systemic Mastitis and trauma (1)	3	10	10	20	30	M	7	full exposure	15	25	35	H	0.375	7.5	H

Figure 17. Risk assessment hazards: related to housing in dairy cows kept in straw yards (continued).

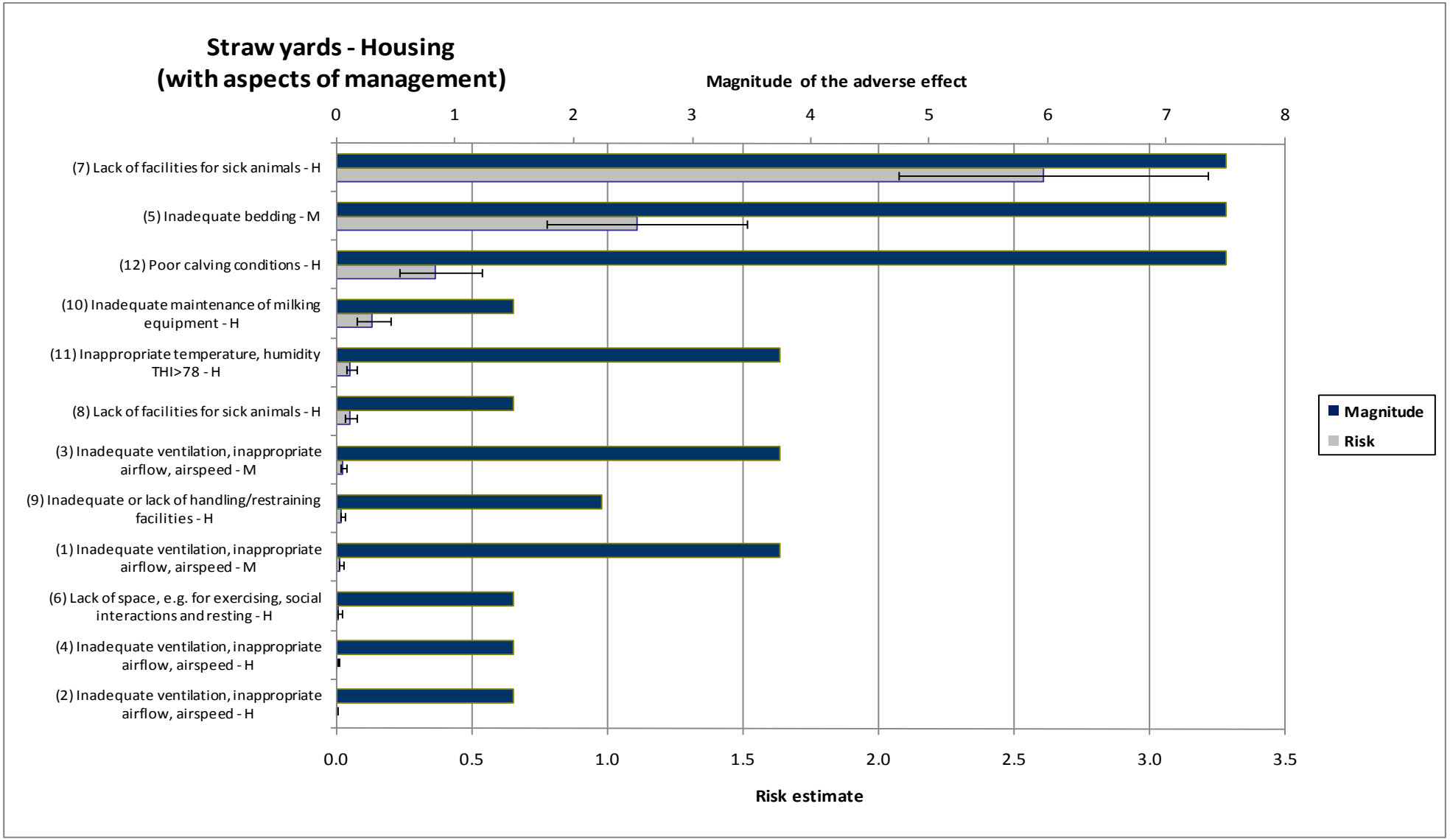

Figure 18. Ranking of hazards related to housing in dairy cows kept in straw yards.

STRAW YARDS				UDDER PROBLEMS																
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
NUTRITION AND FEEDING																			
5.1 / 10.8	1	**Improper ration composition**	Inadequate protein/ carbohydrate ratio and peNDF <20% of dry matter leading to metabolic disorders	Mastitis (3)	2	3	10	20	30	L	90	rumen pH < 5.8 more than 3 hours	10	15	20	M	0.045	1.5	M
5.1 / 10.8	2	**Improper ration composition**	Inadequate vitamine (vit. E) and mineral (Se) supply	Mastitis (3)	2	3	5	10	15	L	305	rumen pH < 5.8 more than 3 hours	15	20	25	H	0.030	1.5	H

Figure 19. Risk assessment hazards: related to nutrition and feeding in dairy cows kept in straw yards.

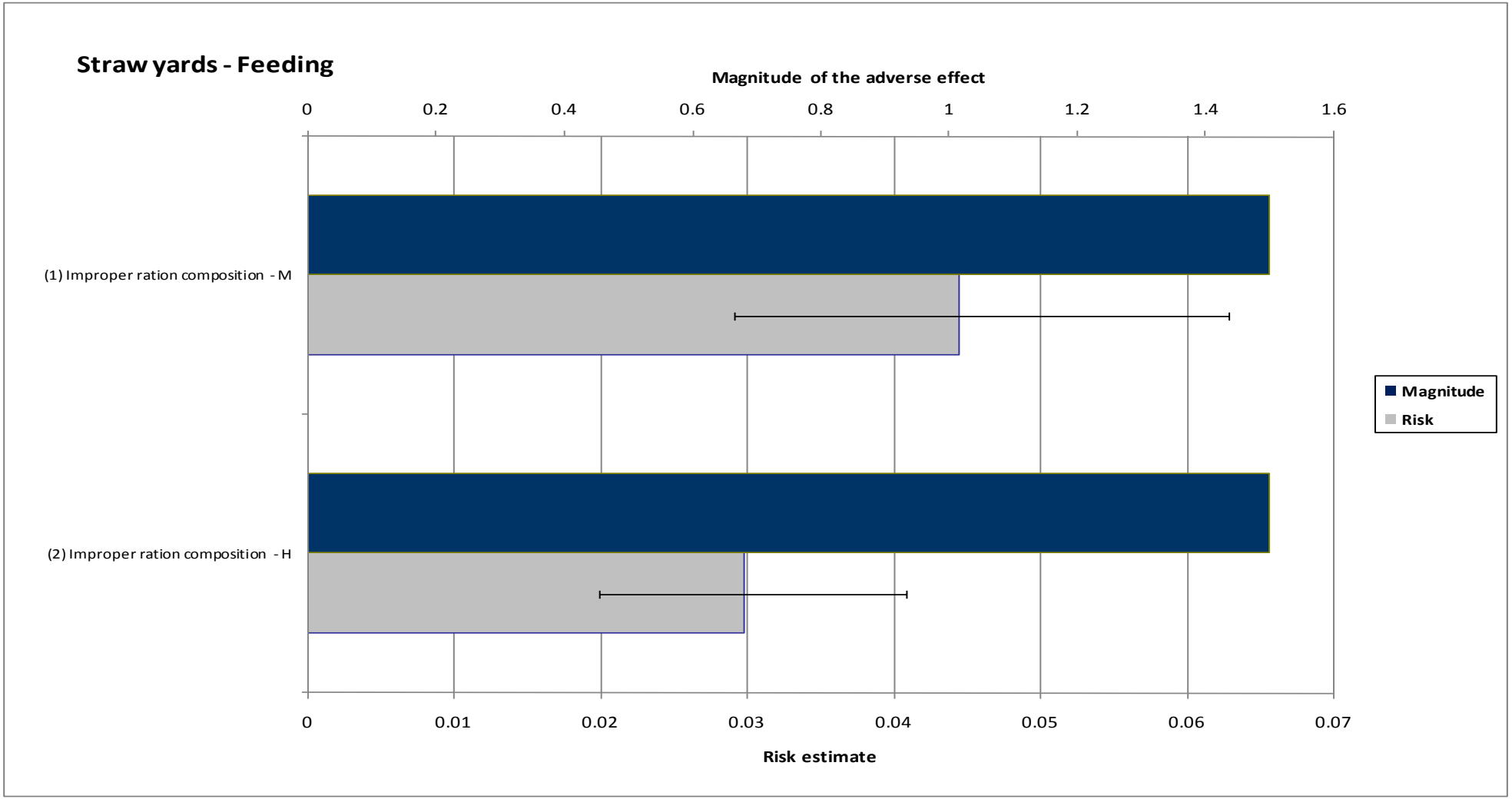

Figure 20. Ranking of hazards related to feeding in dairy cows kept in straw yards.

STRAW YARDS				UDDER PROBLEMS															
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
8.2. / 8.3 / 8.4	1	**Poor calving management**	separation, isolation, immunosupression	Systemic Mastitis (1)	3	5	1	5	10	M	5	full exposure	10	20	30	H	0.038	3.75	H
10.5 / 10.8 / 10.9 / 14	2	**Insufficient or inappropriate care of animals by stockperson**	delayed detection of mastitis due to negligence /lack of knowledge	Increased duration or severity of Mastitis (3)	3	10	50	60	70	L	365	full exposure	20	30	40	H	1.350	7.5	H
7.2 / 7.3 / 10.8 / 14	3	**Inadequate milking procedures**	dipping, milking time, incomplete milking, teat cleaning, blind milking, cleaning and disinfection, separate milking of sick animals	Contagious mastitis and teat disorders	2	5	50	60	70	L	305	full exposure	30	50	70	H	0.750	2.5	H
10.3 / 10.8 / 13.2	4	**Inadequate antimicrobial treatments**	lack of veterinary diagnosis and supervision, treatment too short	Increased duration or severity leading to chronic mastitis	3	10	40	50	60	L	365	full exposure	40	60	80	H	2.250	7.5	H
13.8	5	**Inadequate analgesic treatments**	non treating for pain of a systemic Mastitis	Prolongued pain and discomfort	4	10	80	90	100	L	5	full exposure	5	10	15	H	0.900	10	H
10.4	6	**Inadequate treatments of other diseases**	non treating lame cows	Mastitis and teat trauma	3	5	1	5	10	M	40	full exposure	20	30	40	H	0.056	3.75	H

Figure 21. Risk assessment: hazards related to management in dairy cows kept in straw yards.

STRAW YARDS				UDDER PROBLEMS															
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
12.3	7	**Inadequate biosecurity**	introducing infections e.g. cattle with Mastitis	Mastitis (3)	3	3	30	40	50	L	365	full exposure	50	70	90	H	0.630	2.25	H
12.3	8	**Inadequate biosecurity**	introducing infections e.g. diseased cattle, BVD, IBR, BT…	Mastitis (3)	3	5	1	5	10	M	365	full exposure	50	70	90	H	0.131	3.75	H
12.3	9	**Inadequate biosecurity**	inadequate control of pest and vectors	Contagious Mastitis (4) i.e. summer mastitis	2	10	2	5	7	L	100	full exposure	30	50	70	H	0.125	5	H
10.5 / 10.8 / 10.9 / 14	10	**Inadequate clinical health monitoring and prevention**	including recording and planning of mastitis	Mastitis (3)	3	5	10	20	30	M	365	full exposure	30	40	50	H	0.300	3.75	H
13.7	11	**Downer cow**	Improper management of downer cows - Lack of: physiotherapy, good bedding, proper facilities and lifting devices	Systemic mastitis and teat trauma	4	5	98	99	100	L	15	full exposure	0.5	1	1.5	M	0.050	5	M
13.4	12	**Keeping cows with horns**	Increased agression, trauma and stress	Mastitis and udder trauma	3	10	5	10	15	M	365	full exposure	1	3	5	M	0.023	7.5	M

Figure 21. Risk assessment: hazards related to management in dairy cows kept in straw yards (continued).

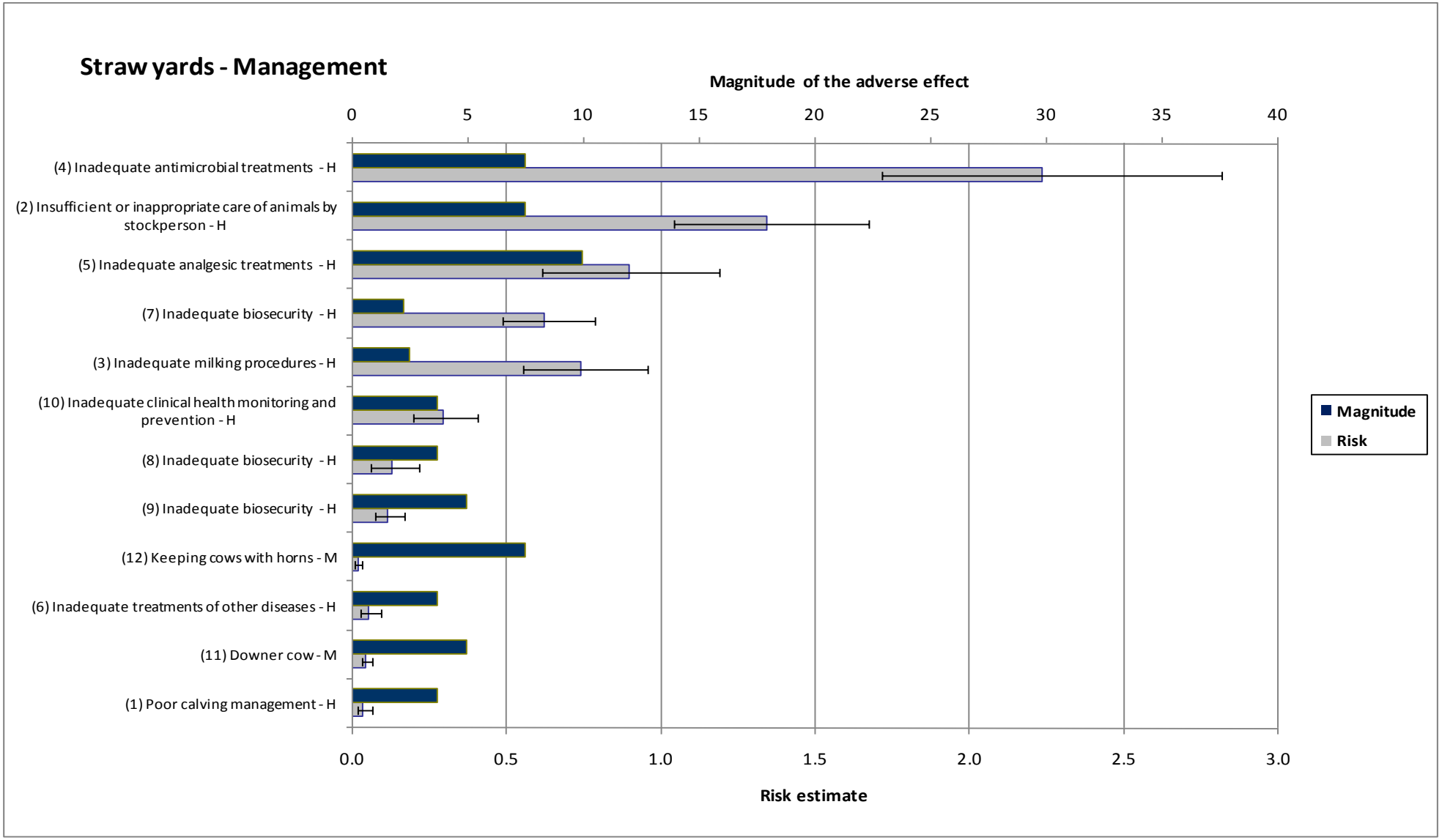

Figure 22. Ranking of hazards related to management in dairy cows kept in straw yards.

STRAW YARDS				UDDER PROBLEMS																
Chapter of the scient. report	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
GENETICS																			
4.2	1	**high genetic potential for production due to selection ignoring other traits**	with good housing, nutrition and management	Mastitis (3)	2	5	20	30	40	L	365	estimated breeding value for yield in top quartile for breed and country	20	30	40	H	0.225	2.5	H
4.2	2	**high genetic potential for production due to selection ignoring other traits**	without good housing, nutrition and management	Mastitis (3)	3	10	40	50	60	M	365	estimated breeding value for yield in top quartile for breed and country	30	40	50	H	1.500	7.5	H

Figure 23. Risk assessment: hazards related to genetics in dairy cows kept in straw yards.

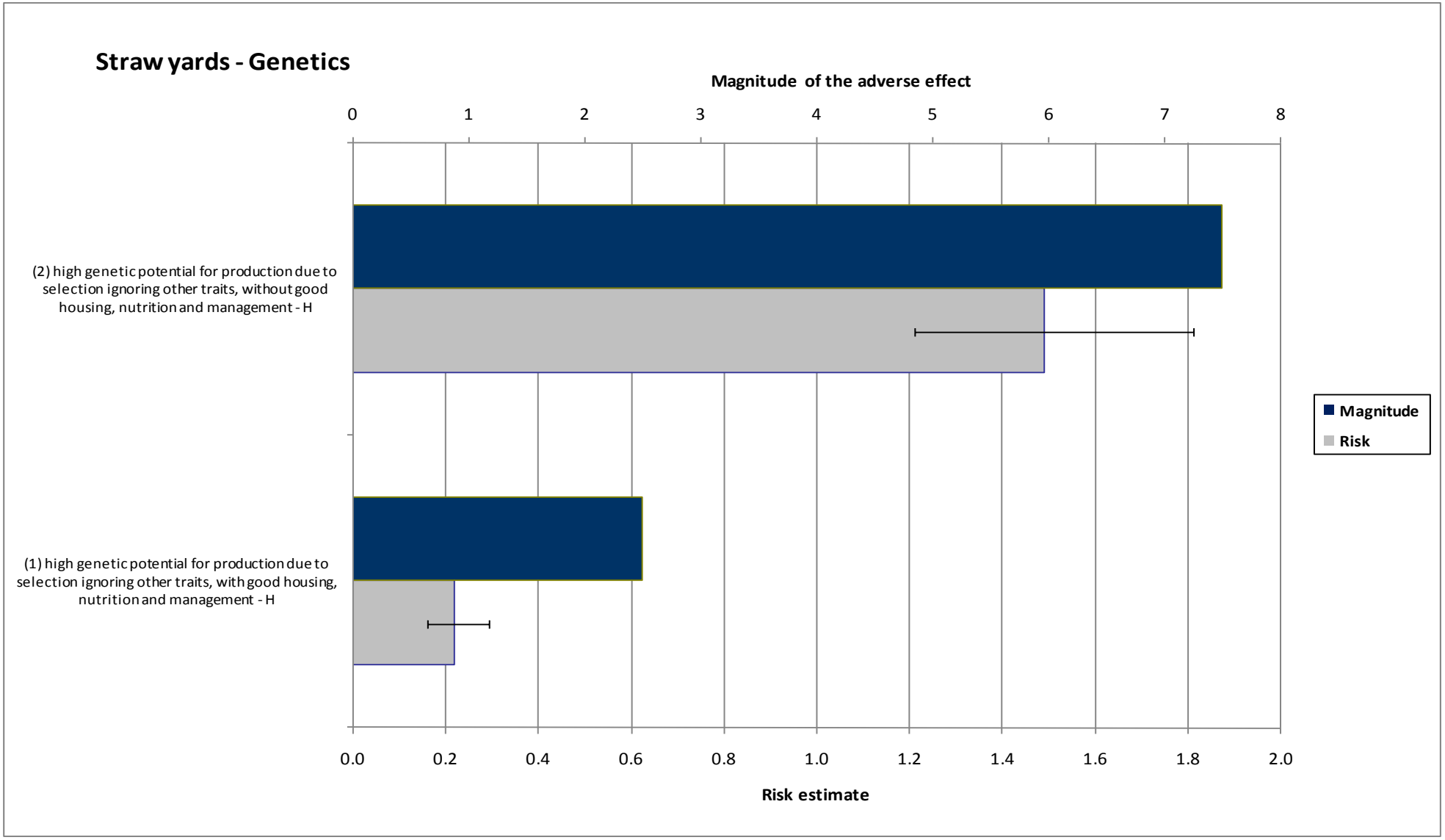

Figure 24. Ranking of hazards related to genetics in dairy cows kept in straw yards.

PASTURE				UDDER PROBLEMS															
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
HOUSING (with aspects of management)																			
6.8	1	**Inadequate pasture**	Wet, muddy	Systemic Mastitis and trauma including teat problems	3	10	10	15	20	M	180	full exposure	10	30	50	H	0.338	7.5	H
12.3	2	**Lack of facilities for sick animals**	cows with Systemic mastitis	pain, trauma, discomfort	3	10	30	40	50	M	180	full exposure	50	65	80	H	1.950	7.5	H
12.3	3	**Lack of facilities for sick animals**	increased infection pressure to remaining population at risk	Localised Mastitis	2	3	1	3	5	H	180	full exposure	50	70	90	H	0.032	1.5	H
13.1	4	**Inadequate or lack of handling/restraining facilities**	_	Trauma, pain	3	3	1	2	3	H	10	full exposure	30	50	70	H	0.023	2.25	H
7.2 / 7.3 / 10.8	5	**Inadequate maintenance of milking equipment**	_	Localised Mastitis and teat disorders	2	3	10	30	50	L	180	full exposure	20	30	40	H	0.135	1.5	H
6.5	6	**Inappropriate temperature, humidity THI>78**	increased infection pressure	Mastitis (3)	3	5	5	10	15	M	10	THI>78	10	15	20	H	0.056	3.75	H
8.2 / 10.8	7	**Poor calving conditions**	poor hygiene and limited space	Systemic Mastitis and trauma (1)	3	10	10	20	30	M	7	full exposure	15	25	35	H	0.375	7.5	H

Figure 25. Risk assessment: hazards related to housing in dairy cows kept in pasture.

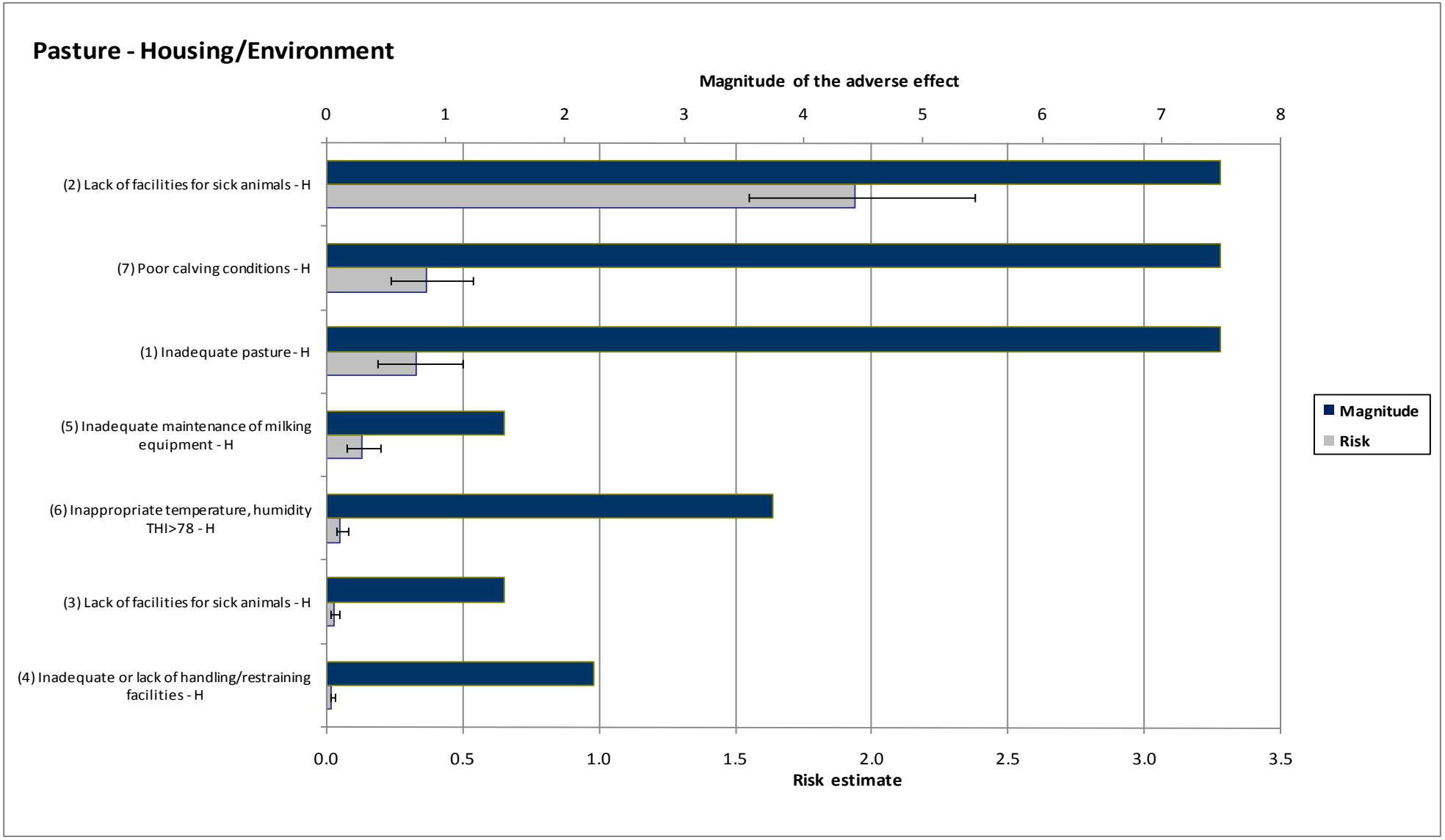

Figure 26. Ranking of hazards related to housing in dairy cows kept in pasture.

PASTURE				UDDER PROBLEMS																
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
NUTRITION AND FEEDING																			
5.1 / 10.8	1	**Improper ration composition**	Inadequate protein/ carbohydrate ratio and peNDF <20% of dry matter leading to metabolic disorders	Mastitis (3)	2	3	10	20	30	L	90	rumen pH < 5.8 more than 3 hours	10	15	20	M	0.045	1.5	M
5.1 / 10.8	2	**Improper ration composition**	Inadequate vitamine (vit. E) and mineral (Se) supply	Mastitis (3)	2	3	5	10	15	L	180	rumen pH < 5.8 more than 3 hours	15	20	25	H	0.030	1.5	H

Figure 27. Risk assessment: hazards related to nutrition and feeding in dairy cows kept in pasture.

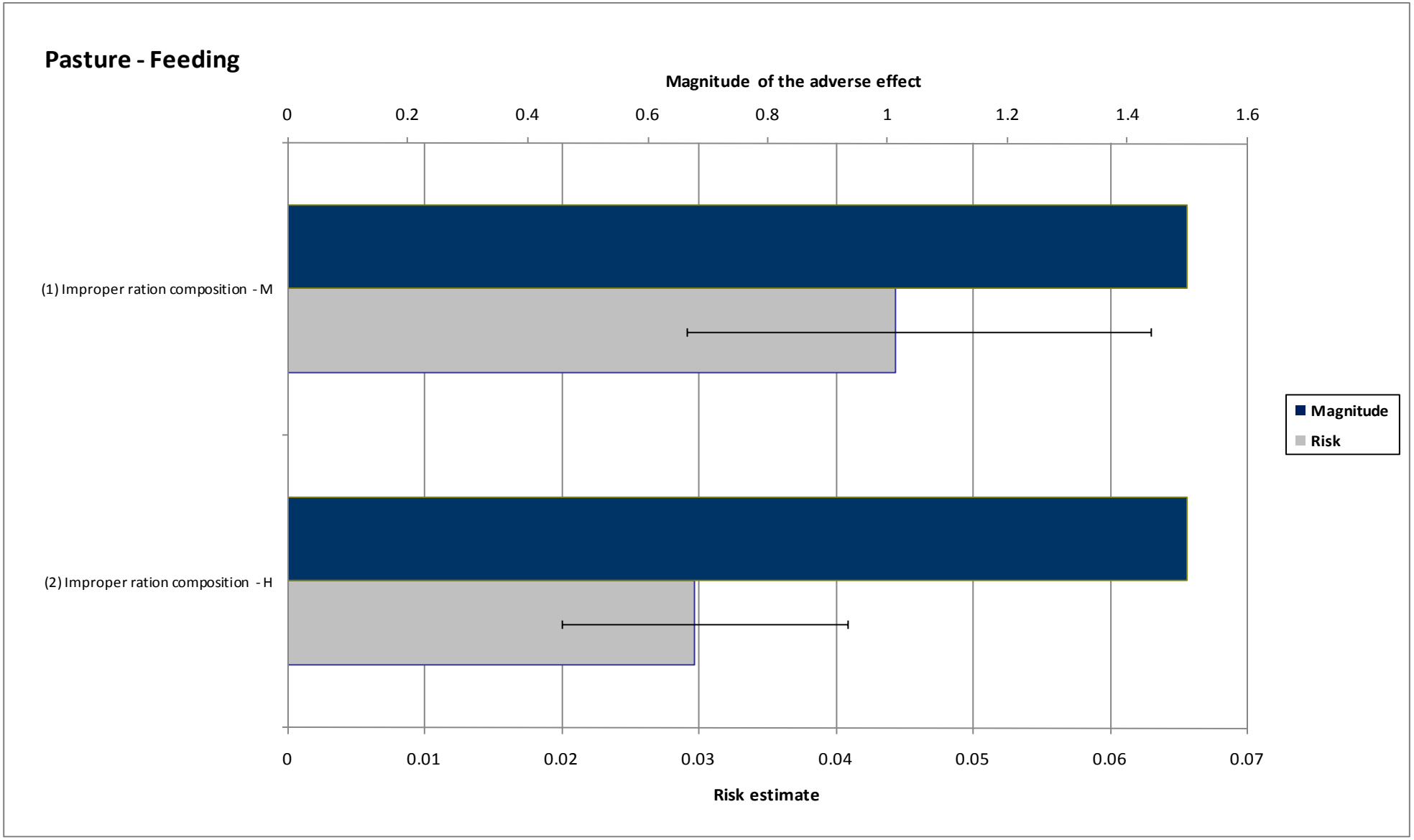

Figure 28. Ranking of hazards related to nutrition and feeding in dairy cows kept in pasture.

PASTURE				UDDER PROBLEMS																
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
8.2. / 8.3 / 8.4	**1**	**Poor calving management**	separation, isolation, immunosupression	Systemic Mastitis (1)	3	5	1	5	10	M	5	full exposure	10	20	30	H	0.038	3.75	H
8.5 / 10.8 / 10.9 / 14	**2**	**Insufficient or inappropriate care of animals by stockperson**	delayed detection of mastitis due to negligence /lack of knowledge	Increased duration or severity of Mastitis (3)	3	10	50	60	70	L	180	full exposure	20	30	40	H	1.350	7.5	H
7.2 / 7.3 / 10.8 / 14	**3**	**Inadequate milking procedures**	dipping, milking time, incomplete milking, teat cleaning, blind milking, cleaning and disinfection, separate milking of sick animals	Contagious mastitis and teat disorders	2	5	50	60	70	L	180	full exposure	30	50	70	H	0.750	2.5	H
10.3 / 10.8/ 13.2	**4**	**Inadequate antimicrobial treatments**	lack of veterinary diagnosis and supervision, treatment too short	Increased duration or severity leading to chronic mastitis	3	10	40	50	60	L	180	full exposure	40	60	80	H	2.250	7.5	H
13.8	**5**	**Inadequate analgesic treatments**	non treating for pain of a systemic Mastitis	Prolongued pain and discomfort	4	10	80	90	100	L	5	full exposure	5	10	15	H	0.900	10	H
10.4	**6**	**Inadequate treatments of other diseases**	–	Mastitis and teat trauma	3	5	1	5	10	M	40	full exposure	20	30	40	H	0.056	3.75	H

Figure 29. Risk assessment: hazards related to management in dairy cows kept in pasture.

PASTURE	UDDER PROBLEMS																		
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
MANAGEMENT																			
12.3	**7**	**Inadequate biosecurity**	introducing infections e.g. cattle with Mastitis	Mastitis (3)	3	3	30	40	50	L	180	full exposure	50	70	90	H	0.630	2.25	H
12.3	**8**	**Inadequate biosecurity**	introducing infections e.g. diseased cattle, BVD, IBR, BT…	Mastitis (3)	3	5	1	5	10	M	180	full exposure	50	70	90	H	0.131	3.75	H
12.3	**9**	**Inadequate biosecurity**	inadequate control of vectors	Contagious Mastitis (4) i.e. summer mastitis	2	10	2	5	7	L	100	full exposure	30	50	70	H	0.125	5	H
10.5 /10. 7 10.8 / 10.9 / 14	**10**	**Inadequate clinical health monitoring and prevention**	including recording and planning of mastitis	Mastitis (3)	3	5	10	20	30	M	180	full exposure	30	40	50	H	0.300	3.75	H
13.7	**11**	**Downer cow**	Improper management of downer cows - Lack of: physiotherapy, good bedding, proper facilities and lifting devices	Systemic mastitis and teat trauma	4	5	98	99	100	L	15	full exposure	0.5	1	1.5	M	0.050	5	M
13.4	**12**	**Keeping cows with horns**	Increased agression, trauma and stress	Mastitis and udder trauma	3	10	5	10	15	M	180	full exposure	1	3	5	M	0.023	7.5	M

Figure 29. Risk assessment: hazards related to management in dairy cows kept in pasture (continued).

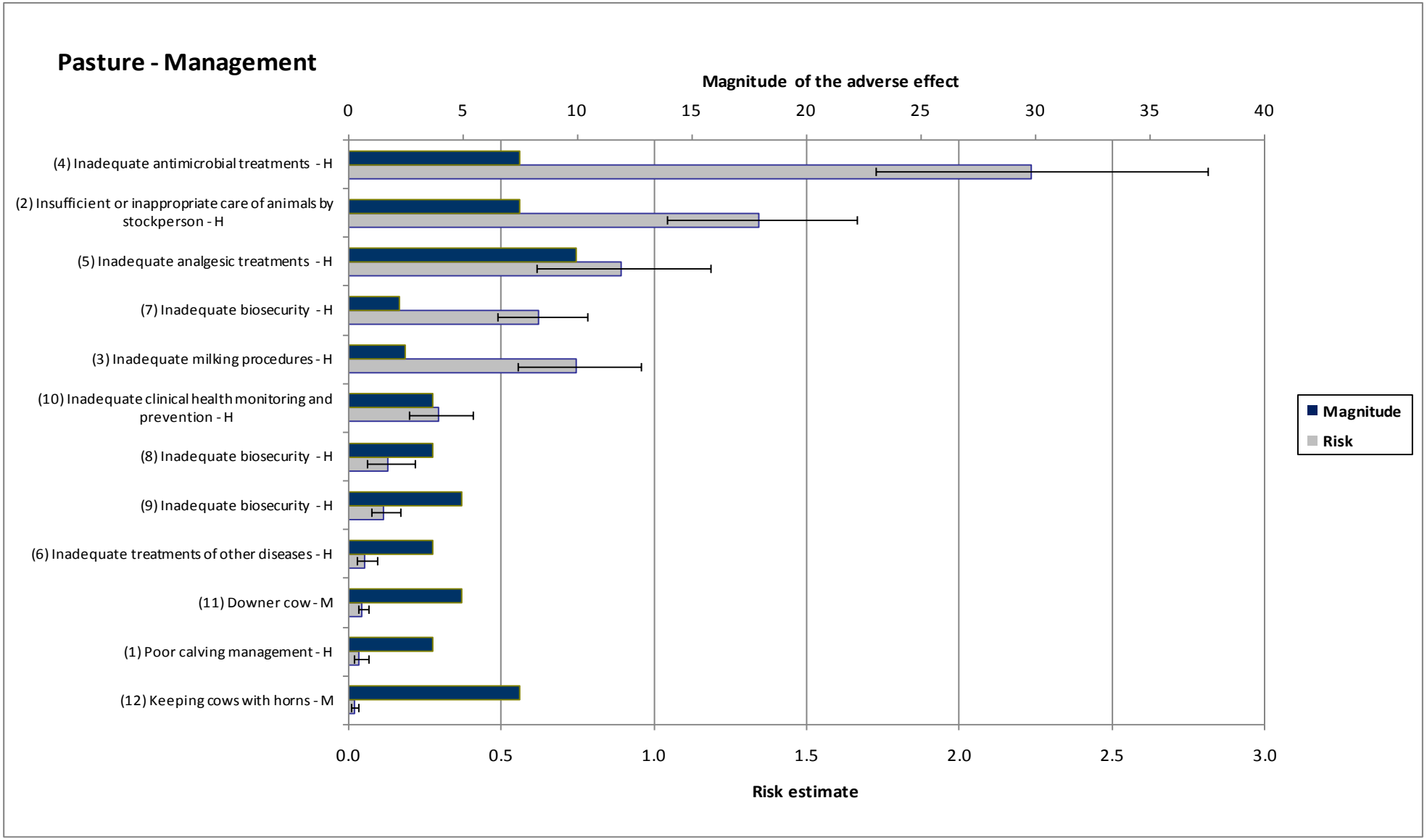

Figure 30. Ranking of hazards related to management in dairy cows kept in pasture.

PASTURE				UDDER PROBLEMS															
	Hazard identification			Hazard characterization							Exposure assessment						Risk Characterization		
Chapter of the scient. report	Hazard Nr.	Hazard description	Hazard specification	Adverse effect	Severity of the adverse effect	Duration of the adverse effect	Likelihood of the adverse effect			Uncertainty	Duration of the hazard	Intensity	Likelihood of the exposure to the hazard			Uncertainty	Risk estimate	Magnitude of adverse effect	Qualtitative uncertainty
							min	ml	max				min	ml	max				
GENETICS																			
4.2	1	**high genetic potential for production due to selection ignoring other traits**	with good housing, nutrition and management	Mastitis (3)	2	5	30	40	50	L	180	estimated breeding value for yield in top quartile for breed and country	20	30	40	H	0.300	2.5	H
4.2	2	**high genetic potential for production due to selection ignoring other traits**	without good housing, nutrition and management	Mastitis (3)	3	10	50	60	70	M	180	estimated breeding value for yield in top quartile for breed and country	30	40	50	H	1.800	7.5	H

Figure 3. Risk assessment hazards related to genetics in dairy cows kept in pasture.

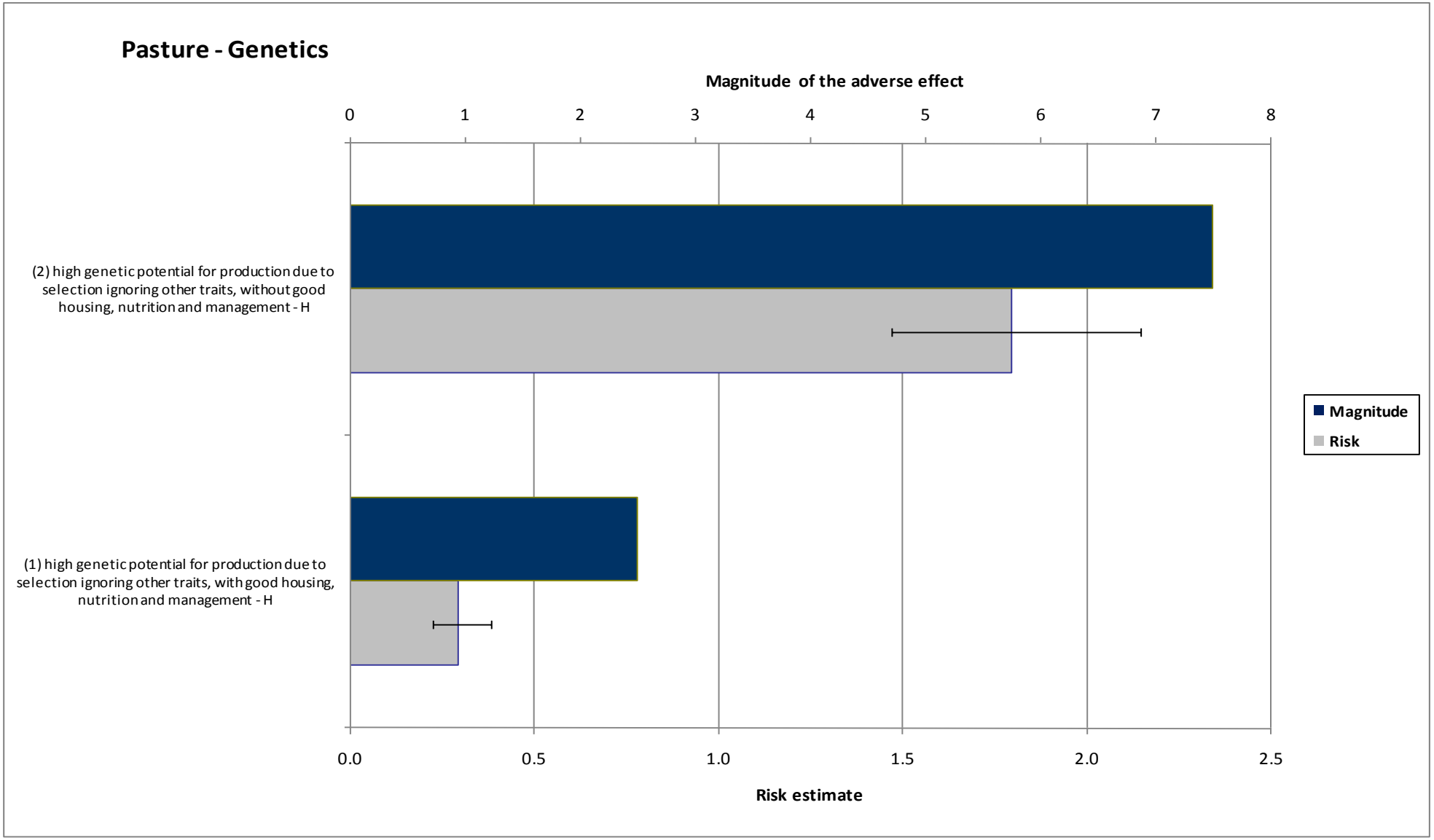

Figure 4. Ranking of hazards related to genetics in dairy cows kept in pasture.

GLOSSARY

Dose-response Assessment

The determination of the relationship between the magnitude of exposure of dairy cows to a certain hazards and the severity and frequency of associated adverse effects on cattle welfare.

Exposure Assessment

The quantitative and qualitative evaluation of the likelihood of hazards to welfare occurring in a given dairy cow population.

Hazard

Any factor, occurring from birth to slaughter, with the potential to cause an adverse effect on dairy cow welfare.

Hazard characterisation

The qualitative and quantitative evaluation of the nature of the adverse effects associated with the hazard. Considering the scope of the exercise of the working group the concerns relate exclusively to dairy cow welfare.

Hazard Identification

The identification of any factor, from birth to slaughter, capable of causing adverse effects on dairy cow welfare.

Localised mastitis (2)

Localized mastitis is one with no systemic illness and so with less impact on welfare. Usually it is caused by "contagious agents".

Magnitude of the adverse effect

The score resulting from the product of the severity and the duration of an adverse effect due to the hazard taken in consideration.

Mastitis (3)

Mastitis is the inflammation of the mammary gland, with an infectious or noninfectious aetiology.

Quantitative Risk Assessment

A risk assessment that provides numerical expressions of risk and an indication of the attendant uncertainties (stated in the 1995 expert consultation definition on risk analysis).

Qualitative Risk Assessment

A risk assessment based on data which, while forming an inadequate basis for numerical risk estimations, nonetheless, when conditioned by prior expert knowledge and identification of attendant uncertainties, permits risk ranking or separation into descriptive categories of risk.

Risk

A function of the probability of an adverse effect and the severity of that effect, consequent to exposure to a hazard.

Risk Characterisation

The process of determining the qualitative or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse effects on welfare in a given dairy cow population based on hazard identification, hazard characterisation, and exposure assessment.

Risk Analysis

A process consisting of three components: risk assessment, risk management and risk communication.

Risk Assessment

A scientifically based process consisting of the following steps: i) hazard identification, ii) hazard characterisation, iii) exposure assessment and iv) risk characterisation.

Risk Communication

The interactive exchange of information and opinions concerning the risk and risk management among risk assessors, risk managers, consumers and other interested parties.

Risk Estimate

The output of risk characterisation. It results from the product of the hazard characterisation and exposure assessment scores.

Risk Management

The process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options (i.e. prevention, elimination, or reduction of hazards or minimisation of risks), including regulatory measures.

Sensitivity Analysis

A method to examine the behaviour of a model by measuring the variation in its outputs resulting from changes to its inputs.

Systemic mastitis (1)

Systemic mastitis is accompanied by toxaemia, fever, pain, loss of appetite. It has much impact on welfare and is usually caused by environmental agents.

Transparent

Characteristics of a process where the rationale, the logic of development, constraints, assumptions, value judgements, decisions, limitations and uncertainties of the expressed determination are fully and systematically stated, documented, and accessible for review.

Uncertainty Analysis

A method used to estimate the uncertainty associated with model inputs, assumptions and structure/form.