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Scientific Opinion on the overall effects of farming systems on dairy cow welfare and disease [1]

Scientific Opinion of the Panel on Animal Health and Animal Welfare

(Question No EFSA-Q- 2006-113)

Adopted on 05 June 2009

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 that a scientific report, an overall scientific opinion and four risk assessments on: i) metabolic and reproductive disorders, ii) udder disorders, iii) leg and locomotion problems and iv) behavioural disorders, fear and pain would be produced. This overall scientific opinion integrates conclusions and recommendations from the scientific report with the outcomes from the four separate risk assessments. In the resulting list of outcomes, conclusions and recommendations considered to have a high priority are evidenced.
This scientific opinion on the overall effects of farming systems on dairy cow welfare and disease was adopted by the AHAW Panel on 05 June 2009.

In considering the welfare of dairy cattle, some of the most important consequences of poor welfare are the occurrence of disease conditions, in particular foot and leg disorders and mastitis. Reproductive, metabolic and behavioural problems are also relevant indicators of poor welfare.
European dairy production is based mainly from specialized intensive farming but there is considerable diversity in how cows are housed and managed. Systems range from grazing all of the year to remaining in a building with zero-grazing. The farming system by itself is a major

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[*] A minority opinion was expressed by 6 members of the Panel (see page 21).

factor determining the health problems of dairy cattle and other aspects of their welfare, partly through housing and equipment and partly through management and handling practices.

Long term genetic selection for high milk yield is the major factor causing poor welfare, in particular health problems, in dairy cows. The milk yield of dairy cows has risen steadily over the last thirty years in Europe with approximately 50 % of this increase estimated to be attributable to genetic selection for milk production efficiency. This selection has also changed the form and size of dairy cows and hence demands on their behaviour and other adaptive mechanisms. The spatial requirements of the dairy cow have increased as well as its vulnerability for mechanical impacts and wounds on the exterior parts of the body, the skin, limbs and claws. The genetic component underlying milk yield has also been found to be positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders. In order to improve dairy cow welfare there is an urgent need to promote changes in the criteria used for genetic selection in the dairy industry. Higher weight should be given to fitness and welfare traits when these may conflict with selection for milk yield. Genetic selection for improved fertility, health and longevity is likely to improve welfare and lead to greater profit for the farmer.

Whilst issues concerning genetic selection are common to different systems, when comparing different farming systems, hazards associated with housing and management variables have the greatest effects on dairy cattle welfare. The following are the major conclusions and recommendations when systems are compared.

Since the body size of cows has increased during the last 20 years, where cubicles are used, they should be wide enough to minimise any movement difficulties or teat trampling. Cubicles and tie-stalls should be designed in such a way that the forward movement of the body of the cow is not thwarted when changing position from lying to standing. The risk assessment exercise confirmed that poor cubicle design and lack of space are the highest ranked hazards, respectively in cubicle houses and tie stalls, in the development of the most common problems in dairy cows. A total space allowance of less than 8.6 m² in cubicle houses negatively affects welfare. Cubicle width should be at least 1.8 times cow hip width. In cubicle houses there should be at least as many cubicles as there are cows in the house. A lying area of at least 2.7 m² / heifer (up to 400 kg) is necessary to avoid negative impact on welfare and production. In loose-housed cows, the area around each feeding place is a location where much aggression can occur. Therefore, the feeding area should be designed in such a way and with sufficient space that all cows can feed with minimal aggression or other interference.

Since leg disorders are the major welfare problem for dairy cattle and leg disorders are a problem also in well managed cubicle houses, alternatives to cubicles e.g. straw yards and improvements to cubicle house design should be considered. When possible, dairy cows and heifers should be given access to well managed pasture or other suitable outdoor conditions, at least during summer time or dry weather. Tie-stalls restrict the voluntary movement and social behaviour of dairy cows. When periods of exercise are possible some of the adverse effects are reduced. Therefore, systems of husbandry and management should involve a minimum time of restricted movement in order that all dairy cows are able to meet their need to show certain behaviours such as grooming, social interaction and exercise. While tie-stall use continues, cows should have daily exercise that involves walking freely inside or outside (except where there are adverse climatic conditions) and also the freedom to carry out other behaviours. A minority opinion on the use of tie-stalls was expressed by some Panel members.

All dairy cattle should be fed a diet that provides sufficient energy, nutrients and dietary fibre to meet the metabolic requirements in a way that is consistent with digestion. When diet is changed there should be carefully controlled transition feeding in order to prevent poor welfare in the cattle. Feeding systems should allow every individual cow to meet her needs for quantity

and quality of feed. Dairy cows should be provided with drinking water whatever their diet. This water should be in sufficient quantity to prevent any dehydration and should be: free from repellent odour and taste, harmful infectious agents, toxic substances and contaminants that can accumulate in body tissue or be excreted in milk. Both indoors as well as outdoors, continuous access to water should be provided. Automatically regulated troughs and drinker bowls should be installed in the animal houses and farmyards.

There should be systems for monitoring the prevalence of lameness by scoring locomotion and foot lesions every 3 to 6 months in all dairy herds. Because of the high risk of lameness in dairy cattle all dairy farmers should implement a lameness prevention programme. On farms with a high prevalence of recognisable locomotor difficulties, e.g. approaching 10%, there should be improvement of housing conditions, genetic strain and management practices.

In addition to improved methods for genetic selection, the prevalence of mastitis should be reduced also through: 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.

Pain management should be part of the treatment of severe lameness and clinical mastitis.
Farmers should be well trained in recognizing signs of disease at early stages and veterinary advice should be sought at an early stage of disease in dairy cattle. Recommendations in this opinion for disease prevention and management should be followed.
The body of research on dairy cattle welfare should be incorporated into codes of practice and monitoring protocols that address potential hazards and incorporate animal-based measures of welfare outcomes.

Key words:
Animal welfare, dairy cows, farming systems, lameness, mastitis, cow behaviour, metabolic disorders, housing, management, genetic selection.

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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[2] 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[3], updating a report on the welfare of calves[4] 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[5] has also been 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 subdivide the risk assessment process 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. In the resulting list of outcomes, conclusions and recommendations considered to have a high priority are evidenced.
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

[2] http://europa.eu.int/comm/food/animal/welfare/actionplan/actionplan_en.htm
[3] http://www.efsa.europa.eu/science/ahaw/ahaw_opinions/1516_en.html
[4] http://europa.eu.int/comm/food/fs/sc/oldcomm4/out35_en.pdf
[5] http://europa.eu.int/comm/food/fs/sc/scah/out54_en.pdf

"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

"Scientific opinion on the overall effects of farming systems on dairy cow welfare and disease"

This scientific opinion concerns the overall effects of farming systems on dairy cow welfare and disease.

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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

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented here below include all conclusions and recommendations extrapolated from the outcomes of the four specific scientific opinions based on the risk assessment process [1) Leg and locomotion disorders; 2) Metabolic and reproductive disorders; 3) Udder disorders; 4) Behaviour, fear and pain].

In addition the opinion includes the conclusions and recommendations obtained from the data presented in the Scientific Report (give link to the report) which are of a general nature or are not specifically linked to any of the above mentioned subjects (e.g. some genetic changes in dairy cattle and infectious disease in relation to dairy farming and management). The conclusions and recommendations are divided into two priority areas (high and low priority) on the basis of the following categorization:

In this opinion, the most relevant conclusions and recommendations were prioritised within each chapter. High priority was given to the major conclusions and recommendations of a general nature of the scientific report and to the conclusions corresponding to hazards with the highest risk estimates and the highest magnitude of the adverse effects for each of the four risk assessments. High priority conclusions and recommendations were then outlined in the text with a **H.**

The conclusions and recommendations are listed referring to the chapters of the Scientific Report in order to facilitate finding the text related to each conclusion or recommendation.

When a conclusion comes from the Risk Assessment it is explicitly stated.

Chapter 1 - Welfare concepts and assessment

Conclusions:

- In comparison with other farmed animals, much research has been carried out on methods for assessing the needs and welfare of dairy cows. **H**
- In considering the welfare of dairy cows, some of the most important aspects of poor welfare are disease conditions, in particular foot and leg disorders and mastitis. Reproductive and behavioural problems are also relevant indicators of poor welfare. **H**

Chapter 3 - Dairy cow farming systems

3.1. Introduction

Conclusions

- The farming systems, including housing and management conditions, are important factors affecting the health problems of dairy cows and other aspects of their welfare, partly through housing and equipment and partly through management and handling practices. Housing and management have multifactorial consequences that can affect cow welfare in both a cumulative and an interactive way.
- During the **risk assessment** exercise, the experts recognised a marked variation in the technical conditions of some production systems among EU countries and, as a consequence, on the impact on the welfare of the cows. The variation specifically appears in the exposure assessment, mainly on housing aspects with respect to tie-stalls

and straw yards, less for cubicle houses or pasture. (Relevant to several different chapters)

- Leg and locomotion problems in dairy cows are multifactorial in origin, so that the magnitude of the adverse effect in individual animals and the risk estimates, measured in terms of herd prevalence can usually be attributed to a combination of hazards associated with housing, feeding management and genetics. The **risk assessment** led to the conclusion that the most important hazards and risks are those associated with housing and management, in particular with the inadequate provisions for lying, standing and walking in cubicle houses and tie-stalls, and inadequate locomotion monitoring and foot care due to poor herd management and stockmanship. In addition, magnitudes of the adverse effects and risk estimates in housing were much greater in systems involving cubicle housing or tie-stalls, than in straw yards or at pasture. (Relevant to several different chapters) **H**
- The **risk assessment** showed that the risk of suffering metabolic and reproductive disorders is independent of the housing system. In the case of hazards related to housing, poor cubicle design and lack of space were the highest ranked in cubicle houses and tie-stalls, respectively. Inadequate ventilation, temperature and humidity were the highest ranked hazard in straw yards. However, the risk estimate and magnitude values in straw yards were much lower than in cubicles and tie-stalls. In pasture, risk estimate values were lower than in the indoor systems considered. Magnitudes of the adverse effect were also lower. The impact of genetics was not so much dependent upon the housing system. (Relevant to several different chapters) **H**
- The **risk assessment** showed that the presence of behaviour, fear and pain problems in relation to the hazards considered can be dependent on the farming systems. The risk estimates for behavioural problems, fear and pain associated with housing were generally higher than the risk estimates observed for the other categories of hazards. (Relevant to several different chapters) **H**
- The **risk assessment** showed 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**. (Relevant to several different chapters) **H**

3.2 Mixed, intensive, extensive and organic farming system

Conclusions

- European dairy production is mainly from specialized farming but there is considerable diversity in how cows are housed and managed. Systems range from grazing the whole year to remaining in a building with zero-grazing.
- Diet ranges from wholly pasture, through those where conserved forage is most of the winter feed, to zero-grazing throughout the year, either grass-based or with a high proportion of non-forage material in the diet. In addition, most European dairy cows are fed a diet that includes a high proportion of concentrates during lactation. Further reduction in pasture use and increase in herd size are likely (ch. 5).

- Organic dairy farming is regulated by a set of standards, in particular requiring that it must be pasture-based and restricting further intensification but allowing increases in scale. Through the higher price of its products in the food market, organic dairy farming has a small but in recent years gradually increasing share in European dairy production.

3.3 Indoor and outdoor housing for dairy cows in different farming systems.

- For dairy cattle, when mats and mattresses in tie-stalls and cubicles are not well-maintained and covered with a layer of litter sufficient to absorb moisture and prevent hock injuries, welfare of dairy cows could be impaired.

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

4.2 Impact of selection and breeding on welfare

Conclusions

- Long term genetic selection for high milk yield is the major factor causing poor welfare, in particular health problems, in dairy cows. **H**
- Genetic selection for higher productivity has changed the form and size of dairy cows and hence demands on their behaviour and other adaptive mechanisms. The spatial requirements of the dairy cow have increased as well as its vulnerability for mechanical impacts and wounds on the exterior parts of the body, the skin, limbs and claws. **H**
- Udder shape and volume, resulting from genetic selection and management, are of specific concern, with respect to normal locomotion, prevention of lameness and comfort during resting in the most common housing types.
- The genetic component underlying milk yield has been found to be positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders. These changes and others that result from genetic selection have increased the size of dairy cattle, made their management more difficult. **H**
- The **risk assessment** showed that genetic selection for high milk yield with insufficient emphasis on other traits relating to fitness increases the risk of suffering leg and locomotion problems. This risk is greater when the animals are kept without substantial compensatory husbandry. **H**
- The **risk assessment** showed that no differences according to housing systems have been observed on the effect of the genetic selection on metabolic and reproductive disorders.
- The **risk assessment** showed that the risk of suffering metabolic and reproductive disorders as a consequence of genetic selection for productivity is higher when the animals are kept without substantial compensatory husbandry (mainly related to feeding).
- The milk yield of dairy cows has risen steadily over the last thirty years in Europe with approximately 50 % of this increase estimated to be attributable to genetic selection for milk production efficiency. **H**
- In recent years, breeding programmes have started to take account of and attempt to improve health, fertility and other welfare-related traits.

- From the **risk assessment** it was concluded that hazards related to genetics show a very low risk of causing behavioural problems compared with other factors. The magnitude of the adverse effect and the risk estimate for behavioural problems was highest for cows with high genetic potential for production due to selection ignoring other traits when the when the animals are kept without substantial compensatory husbandry .
- 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

Recommendations

- The genetics of dairy cattle should be taken into account when designing housing and management methods for these animals. **H**
- In order to improve dairy cow welfare there is an urgent need to promote changes in the criteria used for genetic selection in the dairy industry. These changes should result in animals in which there are fewer demands on their mechanism of adaptability, less lameness, less mastitis, less reproductive disorder and less metabolic disorder. **H**
- Breeding selection objectives for dairy cattle should include resistance to mastitis, lameness and other diseases. **H**
- In order to improve dairy cow welfare, high weight should be given to the full range of fitness and welfare traits, even when these may conflict with selection for milk yield. **H**
- In order to sustain a high milk yield in dairy cattle without associated poor welfare, the prevention of excessive loss of body condition in early lactation should be one of the objectives of genetic selection.

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.

4.2.5. Inbreeding

Conclusions

- Inbreeding has been estimated to be increasing at 0.17 - 0.2% per year in dairy cows. It may also result in small numbers of sires, perhaps with undesirable characteristics, being widely used. This increase may lead to, or be associated with, increased reproductive problems, reduced lifetime milk production and a reduction in breeding performance if it continues. **H**

Recommendations

- In order to avoid poor welfare, such as that associated with reproductive disorders and loss of robustness, the breeding procedures for dairy cattle should be designed to reduce inbreeding. **H**

4.3. Selection for high production and consequences for metabolic stress

Conclusions

- Excessive or prolonged negative energy balance in dairy cows is more likely to occur in the highest producing animals and has been found to be associated with reduced fertility, digestive, metabolic and infectious disease, especially mastitis.

4.4 Selection for improved welfare in dairy cattle

Conclusions

- Genetic selection for improved fertility, health and longevity is likely to improve welfare and lead to greater profit for the farmer. **H**

Recommendations

- A multi-trait selection programme in which health, fertility and welfare traits are included in the breeding objectives is recommended.

Recommendations for future research

- Multi-disciplinary research aimed to clarify the relationship between production, negative energy balance, metabolic stress and welfare indicators and to develop practical methods for measuring negative energy balance and metabolic stress is needed. This research should identify traits and selection criteria to provide better selection tools to improve welfare in dairy cows.

4.5. Use of genetic engineering and novel breeding technologies in dairy cows

- In a previous scientific opinion of EFSA, it was concluded that there was reduced welfare of cattle clones as a consequence of adverse health outcomes.

Conclusions

- Cloning may provide an opportunity to produce animals that have both high productivity and good welfare. However, at present, technologies such as transgenesis and the methods used in cloning can have a substantial negative impact on the welfare of dairy cattle. **H**

Recommendations

- Wherever transgenesis or cloning procedures are carried out on dairy cattle, any effects of the procedures and of any genetic change on the welfare of the animals should be evaluated using an appropriate range of animal welfare indicators. The results of such welfare evaluation studies should be taken into account when considering whether or not to produce or farm such animals. **H**

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

5.1 Feed and feeding practices

Conclusions

- Cattle require a diet that is adequate in fibre. If the quantity and quality of dietary fibre are inadequate, the anatomy and physiology of the rumen are impaired and there is increased risk of ruminal acidosis and other related disorders. **H**
- Cows are often in negative energy balance during early lactation. In these circumstances, functional body tissues may be metabolised and this can cause poor welfare. This risk is particularly severe in high-producing genetic strains. Transition period feeding that sustains dry matter intake while maintaining optimal body condition at calving reduces this risk. **H**
- If the components of feed for dairy cattle lack nutrients or are not balanced, or if the feeding system does not allow each animal to obtain sufficient feed, welfare will be poor.
- In relation to the development of metabolic and reproductive disorders, the **risk assessment** showed that an inadequate transition feeding is the hazard with the highest risk estimates in all indoor farming systems (Note: transition to fresh pasture with low fibre content can also cause problems). No difference among the four farming scenarios has been observed on the impact of an improper ration composition (protein/energy levels at dry period and lactating stages but particularly in the transition period). In the three indoor systems, for total mixed ration the risk estimate is higher for cows kept in cubicles and tie-stalls compared with straw yards. The possibility to eat some straw is higher in well managed straw yard, but can occur also in tie-stalls. **H**
- The **risk assessment** showed that the risk for improper fibre traits (chemico-physical aspects) is quite high in cubicles and tie-stalls but lower for straw yards. For dairy cows kept on pasture, the magnitude of the adverse effect and the risk estimate are much lower, the reason being a diet mainly based on grazed forages.
- From the **risk assessment**, in the case of component feeding, the magnitude of the effect is similar among the three systems, but the risk estimate is lower in straw yards; otherwise the risk is maximal in the case of tied animals associated with the higher difficulties to properly supply concentrates in many small meals.
- From the **risk assessment**, no difference among the three indoor farming systems has been observed on the impact of an improper way of feeding (frequency of supplying feed or diet composition in relation with stage of lactation and/or dry period).
- The **risk assessment** showed that the impact of the underfeeding is lower, both in terms of magnitude of the effect and risk estimate, in tied animals because the possibility of feeding each cow individually is easier. Overfeeding in late lactation and dry period is the second most important risk for all indoor systems. When dairy cows are kept on pasture, the impact of the underfeeding is lower, both in terms of magnitude of the adverse effect and risk estimate, as well as the impact of overfeeding, since forage is the main feed and excess of energy is more unlikely.
- From the **risk assessment**, no difference among the three indoor farming systems has been observed on the impact of forage quality in terms of palatability and nutritional value.
- 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.
- The **risk assessment** showed that the most important hazards for leg and locomotion disorders associated with nutrition and feeding systems are inadequacies in transition

feeding and imbalanced diets. The greatest risk estimate is related to transition feeding. However the probability of risks attributable to nutrition and feeding systems are low relative to those attributable to housing and management.

- The **risk assessment** showed that nutrition and feeding hazards have a relatively low risk of causing behavioural problems in comparison with some housing factors. The risk estimates and magnitudes of the adverse effects of behavioural problems associated with nutrition and feeding were quite similar for cubicle housing, tie-stalls and straw yards; however there were fewer hazards identified for pasture. The highest risk estimate for behavioural problems due to nutrition and feeding was associated with improper ration composition and underfeeding in cubicle houses, tie-stalls and straw yards. The magnitudes of the adverse effects were highest for poor feed quality of the roughage, improper ration composition, underfeeding, and improper sensory quality of the water source. The uncertainty on the bibliographic evidence about the risk estimates is high for all hazards, except for underfeeding where it is medium.

Recommendations

- All dairy cattle should be fed a diet that provides sufficient energy, nutrients and dietary fibre to meet the metabolic requirements in a way that is consistent with digestion. When diet is changed there should be carefully controlled transition feeding in order to prevent poor welfare in the cattle. **H**
- Feeding systems should allow every individual cow to meet her needs for quantity and quality of feed.

5.2 Water

Conclusions

- Dairy cows drink 30 to 174 l/day per animal depending on stage of lactation, even when they have much water in their diet, in particular because of their large output of water in milk.
- If there is an inadequate mean of provision of water from which dairy cattle can drink, for example if only nipple drinkers are provided, or if refill rates are inadequate to provide water, the animals may obtain insufficient water with consequent poor welfare indicated by physiological and behavioural disturbances. **H**
- Adverse effects on dairy cattle are caused by poor water quality, for example the presence of: repellent odour and taste, harmful infectious agents, toxic substances and contaminants that can accumulate in body tissue or be excreted in milk.
- Drinking water should be available for animals at all times, should be palatable for them and should be of suitable quality not only when entering the watering system, but also at the time when consumed by animals. **H**
- Efficient water distribution and delivery systems providing the necessary amounts of water are needed in all dairy cattle keeping systems.
- From the **risk assessment**, no difference has been observed in the impact of water quality on poor welfare among the four farming scenarios.

Recommendations

- A water supply mechanism which allows a cow to put its mouth down into water should be provided. **H**

- Where water troughs are provided, the number and position should be such that the animals do not need to wait too long or to compete for water. **H**
- Dairy cows should be provided with drinking water whatever their diet. This water should be in sufficient quantity to prevent any dehydration and should be: free from repellent odour and taste, harmful infectious agents, toxic substances and contaminants that can accumulate in body tissue or be excreted in milk. **H**
- Both indoors as well as outdoors, continuous access to water should be provided. Automatically regulated troughs and drinker bowls should be installed in the animal houses and farmyards. **H**

5.3 Chemical and microbiological agents and toxic plants

Conclusions

- Contamination of feed-stuffs with noxious substances or carcasses of dead animals can harm dairy cattle.
- Where feed-stuffs are preserved, improper drying, ensiling or storage can lead to the presence of toxins or loss of nutritional quality.
- From the **risk assessment**, no difference among farming scenarios has been observed in the impact of forage quality in terms of absence of pathogens or toxic substances.

Recommendations

- Contamination of feed-stuffs with noxious substances at source or in storage should be avoided.
- Where feed-stuffs are preserved, any drying, ensiling or storage should be properly carried out.

5.4 Metabolic disorders in relation to production pressure

Conclusions

- Ruminal acidosis (acute and subacute) and parturient paresis (milk fever) can cause very poor welfare in dairy cows. Unbalanced diet is the major cause of sub-acute ruminal acidosis. **H**
- When concentrate dispensers are used, appropriate control is necessary to avoid over/underfeeding and reduce the risk of acute ruminal acidosis. Adequate maintenance of the concentrate feeding facilities on dairy farms is an effective prevention measure for ruminal acidosis.

Recommendations

- Concentrate feeding facilities on dairy farms should be adequately maintained and diets carefully balanced so as to maintain optimal ruminal fermentation and to minimise negative energy balance. **H**
- Strategies for feeding and management of the dry cow should be designed to prevent metabolic disorders such as parturient paresis (milk fever) which has an acute severe effect on animal welfare. **H**

Chapter 6 - Housing conditions in relation to welfare

6.1 Building design

Conclusions

- In relation with the development of udder problems, 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. Stall design and bedding (quantity and quality) should be such as to reduce the probability of intra-mammary infection and udder trauma. The lack of facilities for taking care of cows with systemic mastitis is one of the highest ranked hazards in all systems, capable of causing poor welfare due to the increased discomfort, pain and disease duration. Hazards related to housing in pasture have a very low risk probability and if present the magnitude of the adverse effect on the animals is very low. **H**
- If cubicles are too narrow, movement difficulties and teat trampling may occur.
- In relation with the development of metabolic and reproductive problems, the **risk assessment** showed that poor cubicle design and lack of space are the highest ranked hazards in cubicle houses and tie-stalls respectively, with similar risk values. The magnitude of the adverse effect is much higher in the case of tie-stalls.
- The result of the evaluation of the leg and locomotion disorders made in the **risk assessment** was that hazards related to the housing conditions have a major influence on leg and locomotion problems defined both in terms of magnitude of the adverse effect and risk estimate, compared with the rest of the hazard categories. The most important magnitudes of the adverse effect and risk estimates in housing are approximately 10 times greater in cubicle houses and tie-stalls than in straw yards or at pasture. **H**
- Since leg and foot disorders are the major welfare problem for dairy cattle and leg and foot disorders are a problem even in well managed cubicle houses, alternatives to cubicles e.g. straw yards and improvements to cubicle house design should be considered. **H**
- In the **risk assessment,** the risk estimates for behavioural problems, fear and pain associated with the housing/environment conditions were highest for tie-stalls, relatively high for cubicle houses, much lower for straw yards and very low for pasture. The highest overall risk for behavioural problems due to housing was associated with poor stall design in tie-stall housing. The design of the stalls and inadequate bedding are some of the highest risks for behavioural problems in both tie-stalls and cubicle housing. **H**

6.1.2. Feeding area

Conclusions

- The design of some cubicles and tie-stalls, including the positioning of neck-rails and brisket-boards, is such that the forward movement of the body of the cow when changing position from lying to standing is thwarted.
- Incorrect positioning of neck-rails and brisket-boards in cubicles and tie-stalls can cause substantial problems and hence poor welfare even after leaving the cubicles.

Recommendations

- Cubicles and tie-stalls should be designed in such a way that the forward movement of the body of the cow is not thwarted when changing position from lying to standing. **H**
- Where cubicles are used, they should be wide enough, in relation to the size of the cows, to minimise any movement difficulties or teat trampling. **H**

- Cubicles which force the cow to stand up with the front legs first should not be used. **H**
- Cubicle width should be at least 1.8 times cow hip width. **H**

6.1.4 Walking areas

Conclusions

- When there is not a cubicle for every cow in a cubicle house, reduced lying time and aggression with associated poor welfare are more likely to occur. It may also lead to increased lameness and mastitis. **H**
- There is often increased aggression when cows are forced by lack of space to stand and walk close to other cows.
- The **risk assessment** showed that, in cubicle houses, inappropriate flooring in passageways, feeding and milking areas posed the largest risk for welfare associated with behavioural problems, fear and pain. **H**

Recommendations

- In cubicle houses there should be at least as many cubicles as there are cows in the house. **H**
- In cubicle houses, injuries to the cows should be monitored and the cubicles modified or replaced, if repeated injuries occur because of poor design. **H**

Recommendations for further research

- To investigate the optimal dimension and function of walking areas to obtain best possible cow traffic in voluntary milking systems.

Conclusions

- In the evaluation of the leg and locomotion disorders made in the **risk assessment** it resulted that hazards related to the housing conditions had a major influence on leg and locomotion problems defined both in terms of the magnitude of the adverse effect and risk estimate, compared with the rest of hazards categories. In cubicles the most important magnitudes of the adverse effect and risk estimates are associated with inadequate floor in the walking area, poor cubicle design and inadequate bedding. **H**

6.2 Space allowance

Conclusions

- In many cubicle houses, the cubicle length is too short for the cows kept in the building. This problem has become very frequent and severe as the body length of cows has increased during the last 20 years. **H**
- A lying area of at least 2.7 m² / heifer (up to 400 kg) is necessary to avoid negative impact on welfare and production. In dairy cows a total space allowance of less than 8.6 m² in cubicle houses negatively affects welfare. **H**
- In loose-housed cows, the area around each feeding place is a location where much aggression can occur. If food is not continuously available and there is not sufficient space for all cows to feed at the same time, aggression increases as the cow to feeding space ratio increases and the welfare of subordinate cows, in particular, is often poor. **H**
- Having a choice, cows would choose more individual space than is available in most housing systems. Larger space allowance, in the walking area as well as the lying area,

is beneficial for the welfare of cows and heifers with respect to decreased aggression, injuries, and occurrence of lameness. Understocking has positive effects on the welfare.

- In the **risk assessment**, having fewer cubicles than cows was the hazard with the largest magnitude of the adverse effect in cubicle houses, but the risk estimate was relatively low. There was a high degree of uncertainty about the estimates of exposure.

Recommendations

- Cubicle design should be such that no standing, lying or defecation movement is difficult for a cow and should not cause injuries to the cow.
- All cubicles for dairy cattle should be long enough and have an appropriate neck rail positioning to enable each animal to stand comfortably with all four feet in front of the rear kerb.
- The feeding area should be designed in such a way and with sufficient space that all cows can feed with minimal aggression or other interference. In loose-house systems, when food is not ad libitum, there should be sufficient space at the food source for all cows to feed at the same time. **H**
- Space allowance in walking areas for dairy cows should be such that cows can pass one another easily. This requires at least consideration of physical space for two cows to pass (e.g. feeding alley: one cow length plus two cow shoulder width.
- The design of cubicle houses and straw yards should allow all the cattle to have access to lying, feeding and drinking areas without danger of injury or of difficulty with social interactions.
- The tie length and tie stall design should allow the cow to easily reach food and water and to lie down and stand up without difficulties showing normal behavioural pattern.

6.4. Protection from adverse weather conditions

Conclusions

- Due to their high metabolic rate, lactating dairy cows are more likely to be adversely affected by a high temperature-humidity index than by low temperatures. The heat tolerance margin for dairy cows is much narrower than the cold tolerance margin. **H**
- Dairy cows are subject to discomfort when the temperature-humidity index exceeds 75 and severe distress when it exceeds 83.
- Appropriate shelter from wind and precipitation as well as appropriate feeding are of particular importance when dairy cows are kept at low temperature. During periods of hot weather, the main source of thermal discomfort for cows at pasture is excessive solar radiation.
- The increase in milk production has led to increasing metabolic heat production and likelihood of heat stress during lactation in the modern dairy cow. An increase in body temperature and panting are good indicators of heat stress.
- Lactating cows can withstand lower temperatures better than dry cows because of their metabolic output. There will be low temperatures at which welfare becomes poor and tissue damage such as frost-bite will occur but precise information on this is lacking.

Recommendations

- Housing design and ventilation should be able to provide air speeds around housed animals in hot summer conditions (for example, more than 26 °C) of at least 0.6 m/s. **H**

- Cows outdoors should be provided with shelter from excessive solar radiation in the summer, wind and precipitation during cold periods.
- At very low temperatures housed dairy cows should be protected from conditions that may cause frost-bite or other tissue damage. Particular attention should be given to minimising direct heat loss from the udder to a cold floor.
- Dry cows should be kept in good conditions. These need not be the same as those used for cows during the milking period and can include the possibility for sufficient movement to prevent problems listed elsewhere. (refers to many chapters) **H**

6.5. Ventilation, air quality, climate control, manure gases and light

- In relation with the development of metabolic and reproductive disorders, the **risk assessment** showed that inadequate ventilation is highly ranked in the case of indoor systems but values of risk are very different and much higher in the case of tie-stalls. Light level and duration have a very low risk probability and magnitude values when compared with other hazards. Poor air quality was rated as a hazard with a large magnitude of the adverse effect in all types of indoor housing. However, the degree of exposure was low, resulting in low risks for behavioural problems. There was a high degree of uncertainty about the estimates of exposure.
- In relation with the development of behavioural problems, fear and pain, the **risk assessment** showed that, for cows at pasture, hazards associated with housing/environment conditions have much lower magnitude of the adverse effect than for cows housed indoors. The largest risk estimates for cows at pasture for behavioural problems were associated with inappropriate temperature and humidity (in particular when there is no shelter), lack of handling facilities and problems with the milking parlour and waiting areas.

6.5.5. Light

Conclusions

- There is substantial evidence that a longer light duration (16L: 8D, intensity at least 150–200 lux) promotes milk production but effects on welfare are not known.
- During the night period cows can orientate themselves in the barn adequately at a light intensity in the range of 10–30 lux. However, acuity of vision is less at this light intensity and this could cause fear in the cows when they are moving on uncomfortable floor surfaces.

Recommendations

- When distinct activity of the cows is required during night time, a light intensity of more than 30 lux is required.

Recommendations for further research

- Research should be done on the relationship between the daily light cycle and cow welfare.

6.5.4 Gases

Conclusions

- Cows are adversely affected by gas concentrations in dairy cow houses exceeding: ammonia 10 ppm, H_2S a measurable amount e.g. 0.5 ppm, carbon dioxide 3000 ppm.

- If manure or slurry containers are stirred, harmful concentrations of H_2S or NH_3 may be produced in cattle buildings.

Recommendations

- Gas concentrations in dairy cow houses should not exceed: ammonia 10 ppm, H_2S a measurable amount e.g. 0.5 ppm, carbon dioxide 3000 ppm. **H**
- Care should be taken not to stir manure or slurry containers in a way that increases H_2S or NH_3 to harmful levels in cattle buildings.

6.6 Resting

Conclusions

- Dairy cows generally attempt to synchronise lying and standing behaviour so there are often times when all are lying or all are standing.
- Lying time and ease of standing up and lying down are useful indicators of cow welfare and can be monitored.
- About 4 h of the lying time is spent sleeping and a large part of the rumination takes places during lying.
- Cows go through a sequence of movements for lying down and getting up, which may not be possible if there is limited lying area or bad stall or cubicle design.
- Leg and foot disorders are the major welfare problem for dairy cattle, in terms of incidence and magnitude of adverse effect. Leg and foot disorders are a problem in cubicle houses, even if well managed. **H**
- Dairy cows have a strong motivation for lying, and lie down for 7-15 hours per day. The lying time varies between housing systems and can be affected by housing design. Altered patterns of lying down can be a sign of lameness, injury or poor housing design.
- When dairy cattle are kept in cubicle houses, foot and leg disorders are substantially more frequent than they are in straw yards. **H**

Recommendations

- The housing of dairy cows should be designed in a way so that they can lie down comfortably in order to get the amount of rest, lying and ruminating that they need. All cows should be able to lie down at the same time.
- Stall and cubicle design should not affect the normal movement pattern of cows when lying down or getting up.

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. **H**
- Bedding hygiene is important for udder health in all systems.
- In relation with the development of udder problems, 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.

- In relation with the development of metabolic and reproductive disorders, the **risk assessment** showed that inadequate bedding has been also highly ranked in indoor systems with risk probability values higher in the case of tie-stalls.
- In relation with the development of behavioural disorders, fear and pain, the **risk assessment** showed that the highest ranked hazards associated with straw yards were inadequate bedding, lack of space, zero grazing and inadequate flooring where cows walk.
- When cows or heifers are kept in a building, provision of an area bedded with suitable material such as deep straw or a soft lying mat or mattress is preferred by them at lying time and widely used by them.
- Well-managed deep straw or sand reduces injuries, such as skin lesions, as compared with a hard floor. Soft lying mats may cause skin lesions and other injuries unless they have additional bedding. **H**
- In studies comparing the two systems, when heifers or cows are kept on a straw-yard, sole haemorrhages and other claw disorders occur less than in cubicle houses.

Recommendations

- Cows or heifers kept in buildings should be provided with an area bedded with sufficient, dry, compressible, non-slippery material that does not lead to skin lesions.
- Hock, knee and skin lesions should be used as an indicator of the quality of bedding for dairy cattle.

6.8 Locomotion, exercising and use of pasture

6.8.5 Effects of housing on locomotion and exercise

Conclusions

- Knowledge of the locomotor activity is of help in identifying when the flooring or housing design is causing problems for the cows. Cows walk 2-4 km/day when they can do so but if the floor is slippery, the building is poorly lit or there is too little space they may walk much less.
- Tied cows are unable to walk. Exercise of tied dairy cows may have positive effects on their health and helps the farmer to detect oestrus, as well as improving cow welfare.
- Tie-stalls restrict the voluntary movement and social behaviour of dairy cows. When periods of exercise are possible some of the adverse effects are reduced.
- Dairy cattle are motivated to walk independently of the need to feed or drink. For animals free to move, exercise has benefits and no disadvantages unless the cattle are forced to walk too fast (> 5 km/hour) or too far (for example, in one publication 9.6 km/day). **H**
- Dairy cattle are reluctant to be tied, both initially and after a period of exercise and tied cattle have more lameness than those free to move with good flooring and resting facilities.
- In relation with the development of leg and locomotion disorders, in the **risk assessment** the highest ranked hazard was lack of space in tie-stalls.
- In relation to the development of behavioural disorders, fear and pain, in the **risk assessment** zero-grazing was rated as a hazard with a large magnitude of the adverse effect for cows in tie-stalls, straw yards and cubicle housing, but the risk estimate was

relatively low. There was a high degree of uncertainty about the estimates of exposure. **H**

Recommendations

- Dairy cattle should be housed so that they can walk without having to change their normal gait or speed because of slippery or bad flooring, or bad design of the housing system. **H**
- Systems of husbandry and management should involve a minimum time of restricted movement in order that all dairy cows are able to meet their need to show certain behaviours such as grooming, social interaction and exercise
- While tie-stall use continues, cows should have daily exercise that involves walking freely inside or outside (except where there are adverse climatic conditions) and also the freedom to carry out other behaviours such as grooming.

Recommendations for future reasearch

- Currently there is only a limited amount of scientific data linking the period per day of being tied in a tie stall to levels of disease and overall impact on welfare, so this should be studied.

> Minority Opinion by Bo Algers, Harry Blockhuis, Donald Broom, Joerg Hartung, David Morton, Mohan Raj:
>
> In contrast to the Panel majority opinion, it is our opinion that there is sufficient evidence for poor welfare in dairy cattle held in tie-stalls.
>
> It is recommended that dairy cattle should not be routinely kept in tie-stalls as a housing system.

6.8.10 Difficulties in comparing access to pasture with different housing systems

Conclusions

- If dairy cows are not kept on pasture for parts of the year, i.e. they are permanently on a zero-grazing system, there is an increased risk of lameness, hoof problems, teat tramp, mastitis, metritis, dystocia, ketosis, retained placenta and some bacterial infections. **H**
- When dairy cows are kept on pasture there are risks of inclement weather, flies and access to toxic plants.
- When stocking rate is too high and new pasture is not made available at regular intervals, there is an increased risk of parasitism, inadequate energy and fibre intake, inadequate water intake and high competition for feed and water.

Recommendations

- When possible, dairy cows and heifers should be given access to well managed pasture or other suitable outdoor conditions, at least during summer time or dry weather. **H**

6.9 Flooring

Conclusions

- Standing and walking for prolonged periods on concrete floors, or floors that are wet or covered in slurry cause severe foot disorders. Concrete flooring has a higher risk of claw disorders than pasture and straw-yards. **H**

Recommendations

- Dairy cattle should not be caused to stand or walk for prolonged periods on concrete floors or floors that are wet or covered in slurry. **H**

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.
- Dairy cows may be exposed on occasion or frequently to stray voltages in housing, especially in the milking parlour, causing electric shock, usually of low voltage, or the perceived possibility of a shock, leading to substantial behaviour change, pain responses and reduced milk yield.

Recommendations

- Electric cow trainers should not be used. **H**
- Precautions should be taken to minimise the risks of stray voltages in dairy cattle housing.

Chapter 7 - Milking procedures in relation to welfare

7.3 Automatic milking

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 the most important hazards in all systems in the development of udder problems. **H**
- Long waiting times before milking can lead to dairy cows having insufficient time for eating and resting, it may also increase the risk of foot lameness.

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. **H**
- Milking equipment should be checked and maintained at least once every six months.
- Milking equipment/machines should be used and maintained to manufacturers' specifications to avoid trauma to the teat and udder.
- Cleaning of udders should take full account of the risk of transmission of pathogens. **H**

- 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.

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. **H**
- 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. **H**

Recommendations

- Cows should be allowed to have access to food and water independently of visiting the milking robot, except for initial training purposes. **H**
- 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. **H**
- 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

8.1. Social grouping

8.1.3 Affiliate relationships and welfare

Conclusions

- Cattle in stable groups have complex, long-lasting affiliative relationships. Maintenance of stable groups ensures that these relationships can continue, reduces the overall stress level in cows and may improve milk production. **H**
- Grouping and re-grouping of cows often causes increased aggression and can cause lameness, resulting in poor welfare and impaired production. **H**

8.1.5. Grouping, regrouping and welfare

Conclusions

- The level of stress during regrouping or mixing, however, depends on the management strategy adopted and the housing environment.
- In relation with the development of behavioural disorders, fear and pain, in the **risk assessment** the hazard with the highest or second highest magnitude of the adverse effect in the three systems where animals are kept loose was mixing animals from different groups (unfamiliar with one another).

Recommendations

- Husbandry practices should avoid regrouping of dairy cows as far as possible in order to facilitate continuation of long-lasting social bonds, avoid frequent disruption and provide social stability.

8.1.8 Group size

Conclusions

- The social environment in dairy cattle is characterised by early separation from the mother and other adult cows, living in same-sex groups throughout life, and frequent changes in herd composition. In large herds the number of aggressive interactions per cow is reported to be greater.
- Regrouping or mixing on pasture leads to fewest welfare problems as it offers space and good flooring. Appropriate management (e.g. ad libitum feeding of good quality food, separating cows in heat), besides larger space allowance, can minimise social agonistic interactions in the herd in general.
- The level of stress during regrouping or mixing of dairy cows depends on the management strategy adopted and the housing environment.

Recommendations

- There should be development and implementation of housing design enabling selective, yield-matched feeding within a herd (e.g. by selection doors) and thus avoiding regrouping.
- If social mixing of dairy cows is unavoidable, stress should be reduced by providing larger space allowance during grouping in buildings or on pasture.

Recommendations for future reasearch

- There should be research into appropriate management practices to reduce social stress in dairy cows during grouping or re-grouping.

8.2 Pre-partum Management

Conclusions

- Cows outdoors about to calve will separate from the herd and will hide if there are hiding places available.
- When cows have to calve in groups indoors, this may cause disturbance for the cow. An individual calving pen with some visual and auditory contact with other cows gives the cow the best possibility to show normal behaviour and calve without problems. **H**

Recommendations

- Dairy cows calving in buildings should be moved to individual calving pens with some contact with other cows before calving in order to minimise welfare problems. **H**
- Dairy cow housing and management should ensure that there are sufficient calving pens. **H**

8.4. Separation from the calf

Conclusions

- Dairy cows are more active shortly after parturition if they are left with their calf.
- Foster cows that accept alien calves do not necessarily need to be milked.

- Dairy cows allowed to stay with their calf after birth and separated within 24 h show a mild stress reaction after separation. After the mother-young bond has been established, i.e. 2 days or more, the cow shows a stronger reaction after separation, and this reaction becomes stronger the longer the time that they stay together.
- If the cow is placed out of hearing and sight of the calf, the stress reaction of the cow is lower. When cow and calf have been together for prolonged suckling, e.g. 6-12 weeks, weaning plates placed on the calves reduce the stress reaction in the cow after separation.
- There are conflicting research data as to whether it is best for the welfare of the cow to leave the calf with the cow for a prolonged lactation period or to remove it within 24 h.
- Udder health may be improved by restricted suckling (i.e. twice/day).
- In relation with the development of udder disorders, 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).

Recommendations

- At separation cow and calf should be placed so that they cannot hear or see each other. When the cow has nursed her calf for the whole milk period or when she has been a foster cow weaning plates on the muzzle of the calf should be used.

Recommendations for further research

- The duration and management of the period during which calves should remain with the cow after parturition should be further studied.
- The optimal time and procedure for separating the calf from the cow needs to be further investigated.

Chapter 9 - Lameness and welfare

9.2 Incidence and prevalence

Conclusions

- Lameness is mainly a consequence of foot disorders.
- Despite research and increasing awareness of lameness in relation to welfare and lost productivity, there has been no reduction in the prevalence of lameness in the last 20 years.

9.3. Pathology, pathogenesis and treatment (and 9.4)

- A range of pathological conditions may lead to foot pain and lameness in dairy cows and these may be caused by factors such as genetic predisposition, pathogens, feeding regime, building design, flooring or poor hygiene and management.
- Locomotion and foot lesion scores can be used to monitor the prevalence and severity of lameness.
- Weekly attention to foot hygiene in dairy cattle leads to reduction of infectious conditions of the foot.
- When the prevalence of recognisable locomotor difficulties in dairy cattle is above 10%, this indicates that the prevention programme is inadequate.

- The **risk assessment** showed that the most important management hazards causing leg and locomotion problems are those related to inadequate care and monitoring of foot health and hygiene. However the risk estimate and magnitude of the adverse effects are exacerbated by housing hazards and approximately twice as great in cubicle systems and tie-stalls as in straw yards or at pasture. **H**

9.4 Assessment and monitoring of lameness

Conclusions

- A range of clinical conditions lead to foot pain in dairy cows and these may be caused by genetic predisposition, pathogens, feeding regime, building design, flooring or poor hygiene and management.
- Locomotion and foot lesion scores can be used to monitor the prevalence of lameness.
- Weekly attention to foot hygiene in dairy cattle leads to reduction of infectious conditions of the foot.
- A prevalence of lameness of up to 2% is achievable on commercial farms. When the prevalence of recognisable locomotor difficulties in dairy cattle approaches 10%, this indicates that the existing housing and management systems are inadequate. **H**

Recommendations

- There should be systems for monitoring the prevalence and severity of lameness by scoring locomotion and foot lesions every 3 to 6 months in all dairy herds. Proper analysis of data from lameness monitoring should be integrated into subsequent farm management.
- Foot inspection with trimming as necessary should be carried out at intervals not greater than 6 months.
- There should be attention to foot hygiene of dairy cattle on a weekly basis, followed by proper treatment as necessary.
- Because of the high risk of lameness in dairy cattle all dairy farmers should implement a lameness prevention programme. **H**
- Lameness should be prevented although in practice this can rarely be achieved at present. Clinical cases should be given proper veterinary care. When systematic monitoring indicates an increasing prevalence, appropriate corrective measures should be taken at herd level. On farms with a high prevalence of recognisable locomotor difficulties, e.g. approaching 10%, there should be improvement of housing conditions, genetic strain and management practices. **H**

Recommendations for future research

- Develop automated systems for monitoring locomotion and the prevalence of lameness.

9.5 Lameness and Animal Welfare

Conclusions

- Most lame cows are in pain and have greater difficulty in coping with their living conditions than non-lame cows because of the effects of the foot or leg disorder on walking, lying comfort, standing up and avoidance behaviour. **H**
- Lame cows are more likely to become subordinate, lose body condition and are more prone to show reduced fertility and to develop mastitis and metabolic disease.

- Well-executed hoof-trimming can reduce the likelihood of lameness and improve cow welfare but poorly executed hoof-trimming can cause lameness.

Recommendations

- Pain relief should be provided during and after treatment for severe lameness. **H**
- Hoof-trimming should be carried out with care by professionally trained and certified personnel.

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. **H**

Recommendations:

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

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.

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.

10.6 Pain and stress during mastitis

Conclusions:

- 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

- 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. **H**

Chapter 11 - Reproduction and welfare

11.1 Reproductive disorders and welfare

Conclusions

- Reproductive disorders are associated with welfare in two ways: 1) they reflect prolonged or short-term poor welfare, such as lack of oestrus, embryonic loss or early abortion due to stress experienced for longer or shorter time periods around parturition and in early lactation; 2) by causing poor welfare directly, particularly dystocia and genital infections associated with pain or inflammatory reactions. **H**

Recommendations

- To reduce risk of dystocia particularly at first calving, heifers should be inseminated after they reach the mature weight for the breed and only sires known to have low incidence of dystocia should be used to breed heifers. **H**
- Good hygiene should be provided at calving to reduce risk of genital infections.

11.2 Reproductive strategy and welfare

Conclusions

- Many farmers intensively manage the reproductive biology of the dairy cows by using hormonal treatments, such as oestrus synchronization and timed insemination, in order to achieve a calving interval of 12 to 13 months which they perceive as economically optimal. This results in poor welfare as it deprives the animals of a coping mechanism at their disposal, to delay the onset of the reproductive process postpartum, to cope with metabolic stress caused by high production.
- In relation with the development of metabolic and reproductive disorders, the **risk assessment** showed that inadequate biosecurity is the highest ranked hazard in all husbandry systems. The magnitude of the adverse effect is the same. In the case of pasture the risk estimate value is lower than in the other three systems. All hazards related with improper management are highly ranked in all farming systems. However, risk values are very low when compared with inadequate biosecurity and also when compared with housing, nutrition or genetic hazards.

Recommendations for research

- Management of modern dairy cows with extended calving intervals should be evaluated with respect to welfare of the cows.

Chapter 12 - Infectious diseases in relation to housing and management (other than mastitis and leg and foot disorders)

12.2. Expert consultation on the impact of different housing systems on dairy cow diseases

Conclusions

- The expert consultation does not indicate any significant impact of different housing systems on the overall prevalence or outcome of other infectious and parasitic diseases

apart from pasture-based systems on the occurrence of certain diseases caused by agents exposing cattle in particular during outdoor conditions. **H**

- Mechanisms of transmission and factors like e.g. the introduction of infected animals or carriers, the feedstuff offered and the stocking density are more significant for the incidence of many diseases, than the impact of the housing system used. **H**
- A further consideration is that many animals are exposed to more than one housing system, for instance many dairy cows are housed during the winter in northern Europe, and managed at pasture during the summer.
- Regardless of housing system, mastitis and leg and foot disorders are found to be the major diseases of cows in the EU and these have a greater impact on the welfare of dairy cows than the various other infectious diseases. (Chapters 9-12).

12.3 Prevention of infectious diseases (other than mastitis, leg and foot disorders) – Biosecurity and health control

Conclusions

- Actions to minimise the burden of infectious and other diseases are important ways to improve animal welfare. Regardless of housing system, high levels of biosecurity and associated management measures are essential. **H**
- An effective herd health and biosecurity programme needs to be decision-focused and flexible enough to adapt to the unique situations of individual enterprises and requires an understanding of the principles of biosecurity and disease prevention and their adaption to the biology and epidemiology of particular pathogens of interest. **H**
- Quarantine and testing of individual animals is not totally effective as a means to prevent the introduction of diseases with a long incubation period or those for which the diagnostic tests have poor specificity or sensitivity at the individual level. Complementing quarantine and testing by sourcing animals from herds known to be free of the disease or those of an equal or higher health status provides added assurance. **H**
- Biosecurity programmes need to be supported by monitoring and documentation of diseases occurrence and variables like patterns of antibiotic resistance to allow improvement of strategies for prevention and intervention, and also by measures for the early detection of disease. **H**
- Close and frequent inspection of cows and early presentation of sick cattle to veterinary clinical assistance reduce the period of suffering due to disease and reduce involuntary culling due to disease. **H**

Recommendations

- Regardless of housing system, herd health and biosecurity programmes, continuously adapted to the unique situations of each individual enterprise, should be in place to prevent introduction of disease and pathogens to the dairy herds and to control spread within the herd. **H**
- Biosecurity programmes should be supported by monitoring and documentation of diseases occurrence and variables like patterns of antibiotic resistance, and applied strategies for prevention and intervention should, when justified, be adapted along with new epidemiological information. **H**

- Measures for the early detection of disease should be in place and farmers and stockpersons should be well trained to recognise disease at early stages. Veterinary attention should be sought at early stages of disease.
- Replacement stock should be sourced from specified-disease-free herds or those of an equal or higher health status.
- Cows should be inspected for disease daily and there should be extra checks around calving and the first three weeks of lactation.
- Hygienic precautions especially at calving and at milking time should be envisaged for reducing disease transmission.

12.3.1 Cow marketing and local movements of animals

- **Conclusions** Transport and movement of animals is often an integral part of different dairy cow systems, which is associated with substantial risks of poor welfare and spread of infectious diseases.

Recommendations

- Efforts should be made to minimise the transport of animals in particular between herds, and when such transports are applied special attention should be given to the reduction of associated risks of poor welfare and spread of infectious diseases. (See also previous scientific opinions) **H**

Recommendations for future research

- The effects of transport on dynamics of disease spread should be further assessed.

12.3.2 Facilities for diseased or contagious animals

Conclusions

- If pens for sick cows are also used for calving, the risk of disease transmission is increased.

Recommendations

- Dairy farms should have facilities for severely ill or injured animals and such animals should be moved to these facilities as soon as possible. **H**
- Facilities for sick animals with infectious diseases should not be used for calving. **H**

12.3.3 Drug usage and welfare

Conclusions

- Lack of proper veterinary surveillance and training of stockpersons responsible for drug administration can result in substantially increased disease and poor welfare.
- Frequent and improper use of intra-mammary antimicrobials facilitates the occurrence of multiple resistant bacteria.
- In some cases drugs are not used because of their cost or because of concerns about human food safety in spite their use is required for relief of pain and suffering in animals.
- There is no evidence that deficits in nutrition, housing, handling and management leading to poor fertility in dairy cattle can be compensated by hormonal treatments.

Recommendations

- Any medication for dairy cattle should be used according to legislation, written codes of practice, veterinary prescription and manufacturer's advice.
- Antimicrobials should not be used as a replacement for good management and the continuous implementation of preventive measures should be prioritized in order to avoid problems with antimicrobial resistance and associated bad welfare.
- Hormonal treatments to improve fertility should not be used to compensate for deficits in management.

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.

13.1 Human-animal relationship

Conclusions

- Fear of humans is exacerbated by poor handling methods and reduced by appropriate experience of human contact. Calm and gentle contact with cattle improves later welfare and production.
- The use of aversive handling techniques, such as electric cattle prods, hitting with sticks, vigorous tail-twisting and excessive fear-inducing behaviour all cause poor welfare in cows and tend to reduce ease of handling in the future and productivity. **H**

Recommendations

- In order to improve welfare and production, young cattle should be given appropriate experience of human contact and all cattle should be handled calmly with gentle contact.
- Stockpersons should receive training in animal management methods and animal welfare. **H**
- Electric goads should not be used on cattle. **H**

13.2 On farm monitoring

Conclusions

- In relation with the development of udder disorders, 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.
- In relation with the development of behavioural disorders, the **risk assessment** showed that withholding necessary veterinary therapeutic health care/poor health care and welfare plan is the hazard with the highest or second highest risk estimate in all the systems. The magnitude of the adverse effect and the risk estimate are not very high for withholding necessary veterinary therapeutic health care, mixing of animals as well as for improper analgesia. These hazards might very well lead to extremely poor welfare and thus unnecessary suffering, although for short periods and only for a smaller number of animals.

Recommendations

- 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. **H**

13.3 Movements of cattle on farm

13.4 Animal identification and mutilations

Conclusions

- Hot-iron branding causes severe pain in cattle. Freeze-branding conducted properly and tags that involve small injuries cause poor welfare but much less than hot-iron branding. Micro-chip insertion causes only slight discomfort. **H**

Recommendations

- Cattle should be marked using micro-chips, freeze-branding or tags that involve small injuries. Hot-iron branding causes severe pain and should not be used. **H**

Conclusions

- De-horning of heifers and cows causes severe pain. Regional anesthesia and analgesia reduce this pain. Use of a sedative makes the operation easier to carry out and there is less risk of injury to cow or person. Disbudding with anesthesia and analgesia when the animals are calves is less traumatic than de-horning. **H**

Recommendations

- De-horning of heifers and cows should be avoided wherever possible and carried out only with the use of regional anaesthesia and analgesia. Disbudding when the animals are calves should be carried out, if horn removal is necessary, but anesthesia and analgesia should be used. **H**

Conclusions

- 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. **H**

Recommendations

- The tails of cattle including dairy cows should not be docked. **H**

13.5 Reproduction: artificial insemination, embryo transfer, semen collection, natural mating.

Conclusions

- Cows calving in a group in a small space may be disturbed by other cows, with resultant poor welfare, or their calves may be stolen by other cows.
- Leaving the placenta on the floor leads to increased disease risk.
- Calving difficulties in heifers are more likely if they have not reached 65% of their expected mature weight by the time of service than if they are more fully grown.
- Careless or improper handling of cattle can cause poor welfare during: milking, artificial insemination, service, embryo transfer, caesarean section, and normal calving.

Recommendations

- The placenta should be removed from the floor of the calving pen as soon as possible.
- Service of heifers should not occur until they reach 65% of their expected mature weight to reduce potential for calving difficulty.
- Dairy cattle should be handled carefully, for example during: milking, artificial insemination, service, embryo transfer, caesarean section, and normal calving.

13.6 Slaughtering: on-farm procedures.

Conclusions

- Improperly conducted procedures or inappropriate equipment used to kill cattle on farm may fail to induce immediate unconsciousness or death.

13.7 Severely sick, traumatised or exhausted animals. Downer cows

Conclusions

- Analgesics are useful in maintaining the comfort and appetite of the downer cow and frequent cleaning of the stall and skin cleansing will prevent sores.
- **Recommendations** Downer cows should have food and water within easy reach, care should be taken to prevent spilling of water that would contact the cow and manual assistance should be offered at regular intervals to aid recumbent animals in their attempts to stand. If the prognosis is hopeless or very poor, then euthanasia on welfare grounds should be advised. **H**
- On-farm killing of downer cows or other cattle should be carried out only by the use of a humane method. **H**

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.

Chapter 16 – On- farm monitoring of dairy cow welfare

16.1- Dairy cow welfare assessment protocols

Conclusions

- The longevity of dairy cows has declined greatly over the last 40 years because of voluntary and involuntary culling. Culling occurs almost always because of the perceived malfunctioning of the cow involving the cow's difficulties in coping with the housing and management system or other aspects of its environment, reduced longevity indicates poorer welfare. **H**

Recommendations

- The outcomes of research on dairy cattle welfare should be incorporated into codes of practice and monitoring protocols that address potential hazards and incorporate animal-based measures of welfare.

REFERENCES

See Scientific Report.

GLOSSARY

Agonistic behaviour

A form of social interaction that is associated with aggression, and that also includes threatening and submissive behaviour.

Anaesthesia

Loss of feeling or sensation produced by an agent. In cattle, local or regional anaesthesia, blocking peripheral conduction of sensation, are far more common than general anaesthesia.

Analgesia

Relief of pain without loss of counsciousness; absence of pain or noxious stimulation.

Biosecurity

Biosecurity in relation to the dairy operation is defined as a strategy of management practices to prevent introduction of disease and pathogens to the operation and to control spread within the operation.

Calf

A calf is a young bovine which is not reproductively active. There is a gradual transition from a newborn animal, dependent on milk, to an animal with many adult characteristics. In this report, calf is used for animals of up to 8 months.

Claw

One of the two digits of a cow's foot.

Cope

Have control of mental and bodily stability or maintain control of mental and bodily stability in the face of a challenge. This control may be short-lived or prolonged. Failure to be in control of mental and bodily stability leads to reduced fitness.

Cubicle

A place for a single cow to stand or lie, which is separated from other cubicles by walls or dividers. The cows are not tied in the cubicle and can enter and leave at will. Such cubicles or stalls are usually in a building that includes many such places, each with access to a passage and areas for walking, feeding, dunging and social interaction (a cubicle house or free-stall barn).

Drylots

Loose housing in outdoor, open or sheltered corral, normally with an earth floor and feed bunk.

Dystocia

Difficult parturition to the point of needing human intervention.

Exploration

Any activity carried out by an individual in order to acquire new information about its environment or about itself.

Foraging

Behaviour of animals moving around in such a way that they are likely to encounter and acquire food.

Free-Stall

See cubicles.

Grooming

The cleaning of the body surface or rearrangement of pelage by licking, nibbling, picking, rubbing, scratching or application of aqueous liquids. Grooming may be performed by the animal itself (auto-grooming) or by a social companion (allogrooming).

Heifer

A young cow from 8 months until her first parturition.

Hierarchy

An ordered sequence of individuals or groups of individuals in a social system which is based upon some ability or characteristic, most often to act aggressively towards or displace group members or to have priority of access to some resource.

Hock

The ankle joint and tarsus of a cow.

Multiparous cow

A cow from the end of her first lactation onwards.

Need

A requirement, which is part of the basic biology of an animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus.

Nurse

The process by which a mother mammal allows a young animal to obtain milk from its teats.

Pasture

Field for grazing.

Peri-natal mortality (PM)

Death of calves at birth or during the first 24 hours after delivery.

Robustness

The extent of the possibility for a population of animals to have the capacity in its gene pool to deal with a wide range of circumstances.

Slatted Floor

A combination of solid parts (slats), which would support the lower surface of the claw of the cow, and gaps (slots) which would allow manure and other liquids to pass through. (Also called slotted floor.)

Solid floor

A continuous flat surface which might be made of various materials and which allows full contact with and support to the lower surface of the claw of the cow.

Somatic Cell Count (SCC)

Number of cells per unit of milk (usually ml). Because the majority of cells are leucocytes, milk SCC is now a standard indicator of udder infection. A level over 100,000 cells/ml is often

considered as a sign of mastitis. The usual measures are the individual cell count and the bulk milk cell count.

Space allowance

The area of animal accommodation per animal or per unit of weight of animals. In some studies the term space allowance also takes account of the volume of the building.

Space allowance at feeder

The length of feeding space per animal or per unit of weight of animals.

Stanchion-Barn

A building containing tie-stalls.

Starvation

An energy availability deficit which results in metabolism of functional tissues rather than just food reserves.

Stereotypy

A frequently-repeated, relatively invariate sequence of movements which has no obvious function.

Still-birth

Delivery of a fully formed dead neonate.

Stocking density

See space allowance.

Straw yards

A building housing cows with a strawed lying area and usually with unstrawed feeding and dunging areas.

Stress

An environmental effect on an individual that over-taxes its control systems and reduces its fitness or has the potential to do so.

Suckle

The process by which a young mammal obtains milk from the teat of its mother or another lactating female by sucking.

Thermoneutral zone

The temperature range within which metabolic heat production and energy expenditure are minimal, most productive processes are at their most efficient level and an animal is thermally comfortable without the need to change heat production. The zone is limited by the lower critical temperature (LCT) and the upper critical temperature (UCT); above and below there are energy costs of thermoregulation.

Tie-Stall

A lying and standing place in which a single cow is tethered to a stanchion.

Weaning, weaned

In mammals, weaning is a gradual process during which the young animal receives less and less milk from its dam and consumes more and more solid food. It is accompanied by changes in the dam-offspring relation. In dairy farming, calves are often separated from their dams

soon after birth and receive milk (or milk replacer) from humans or a machine. Although separated from the dam, calves are considered as un-weaned as long as they are fed milk and the term weaning is used to refer to the process of removing milk from the calf's diet.

Zero-grazing

Feeding cattle with pasture plants or other food in a system that does not involve any time at pasture.