SCIENTIFIC OPINION

Scientific Opinion on welfare aspects of the management and housing of the grand-parent and parent stocks raised and kept for breeding purposes[1]

EFSA Panel on Animal Health and Welfare[2, 3]

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ABSTRACT

This scientific opinion describes welfare aspects of the management and housing of the grand-parent and parent stocks (broiler breeders) raised and kept for breeding purposes in EU member states. The health and welfare consequences were reviewed and a risk assessment on the impact of housing and management on the welfare of broiler breeders, including the influence of genetic selection for fast growth, was carried out. Quantitative data on the different types of husbandry and management systems used in Europe is lacking. In the risk assessment process, the overall top five hazards according to risk scores were barren environments, high stocking density, fast growth rate, feed restriction and low light intensity. These varied slightly when the rearing-laying periods, males-females, and fast-slow growing birds were each analysed separately. It is recommended that birds requiring less feed restriction should be selected as future breeders even if this may involve reduced selected pressure on high growth rates. To track improvements over time, the degree of feed restriction required to maintain broiler breeder target weights should be monitored. It is recommended that the prevalence and effectiveness of different types of mutilations is collected and that no mutilation with an effect on welfare as severe as those resulting from cutting off toes or dubbing the comb should be carried out unless justified by evidence for a substantial and unavoidable level of poor welfare in the birds themselves and other birds. Furthermore it was recommended that animal-based welfare outcome indicators for use during monitoring or inspection of breeder stocks, as well as for monitoring trends over time should be developed.

KEY WORDS

animal welfare, meat producing chickens, broiler breeders, parents and grand-parents, genetic selection, housing and management, risk assessment, systematic review.

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SUMMARY

On request of the European Commission, the European Food Safety Authority (EFSA) prepared a scientific opinion on welfare aspects of the management and housing of grand-parent and parent stocks raised and kept for breeding purposes.

Over the second half of the 20th century, the growth rate of commercially-produced broiler chickens has increased at the same time as the feed conversion ratio has been reduced. It has been shown that this improvement is largely the result of genetic selection. It is generally accepted that many of the welfare problems in broiler breeders are caused by genetic factors, environmental factors and the interaction between them. The limited number of breeder companies that provide the various strains of broilers used worldwide and widely used guidelines for the housing and management of the grand-parent and parent stocks have the opportunity to influence the welfare of broiler breeders.

The comprehensive work related to this mandate was carried out in close collaboration with the working group on the influence of genetic parameters on the welfare of commercial broilers. It involved collecting available data from the industry (technical hearings), information provided by stakeholders (technical meeting and web-consultation) and from a public call for data. One of the other major sources of information referred to in this report is the scientific literature search by systematic review under Article 36.[4]

In the opinion the following key points were considered - the housing and management of broiler breeders (parents and grand-parents) in EU member states; the health and welfare consequences; the use of indicators in practice and a risk assessment on the impact of housing and management on the welfare of broiler breeders, including genetic selection influences.

In general, parent stock management manuals supplied by the breeding companies are used as guidelines when constructing houses or establishing management practices for breeder flocks. Nevertheless, aspects such as national legislation, regional climate or local traditions lead to some specific differences between countries and companies. As a result, there is little overview and no quantitative data and on what husbandry and management systems are used in Europe. Housing and management of grand-parent stock is in general similar to that of the parent stock, but with slightly lower stocking densities and greater emphasis on biosecurity and vaccination. Cage housing can be used for grand-parent stock, but it is rare.

At the hatchery, chickens that will become parent and grand-parent stock undergo several procedures before they are transported to the rearing farm. At the hatchery, birds are sexed and commonly vaccinated. They may also undergo one or more mutilations (e.g. despurring, detoeing, toe clipping, beak trimming) which have been introduced to reduce injury to other birds in the flock, e.g. feather and skin damage. Mutilations are carried out depending on the country or at the request of the customer and it is recommended that quantitative information on the frequency of the different types of mutilations and the methods used in member states should be collected. Furthermore, the consequences for welfare and the effectiveness of mutilations are unknown and some seem to have become routine for traditional reasons and may no longer be required. It is recommended that no mutilation with an effect on welfare as severe as those resulting from cutting off toes or dubbing the comb should be carried out unless justified by evidence for substantial and unavoidable level of poor welfare in birds themselves and other birds. Mutilations should be carried out by trained personnel using the least painful methods.

From day one to approximately 18 weeks of age (rearing period), young broiler breeder birds are kept in single-sex flocks of about 2,500-3,000 birds, in special light regimes, under high biosecurity

[4] Lefebvre D, Tatry MV, Shepers F, Rodenburg BT, Huneau-Salaün A, Allain V, 2010. Toward an information system on broiler welfare: Genetic selection Aspects (TOGA). Technical report submitted to EFSA. Available at: http://www.efsa.europa.eu.

requirements. Records are kept on their origin, growth rate, feed consumption, daily mortality and any intervention. At the age of 16-21 weeks the birds are transferred to the production farms where they stay until they are about 60-65 weeks (production period). In most cases natural mating is used and, although aggression by males during mating can cause welfare problems, the extent of the injuries or their prevalence is unknown. Management influences this, but there may also be a genetic component that could be used to reduce it.

The amount of feed supplied during rearing is restricted in accordance with set programs limiting growth rate and body weight to maintain good health and achieve desired levels of fertility. Although there is a lack of data on the effect of feed restriction in broiler breeder males and more research is required. Feed restriction causes welfare problems associated with hunger and leads to increased competition around feeding time, which may in turn lead to injured birds. But not restricting feed intake will also cause welfare problems in standard birds because of the high body weights. Alternative feeding strategies, like diet dilution and/or appetite suppressants, do not clearly benefit broiler breeder welfare. There is a genetic component as the degree of restriction necessary, for example for mini breeders, is lower than for standard breeding birds. Nevertheless, the degree of restriction has been increasing over the past few decades in response to genetic selection for higher growth rates. It is recommended that birds requiring less feed restriction should be selected as future breeders even if this may involve reduced selection pressure on high growth rates. To track improvements over time, the trend in the degree of feed restriction required to maintain broiler breeder bodyweight targets should be monitored.

Most of the research on welfare indicators has been carried out with broilers or laying hens. Although many may also be used as indicators of welfare in broiler breeders, animal-based welfare outcome indicators for use during monitoring or inspection of grand-parent and parent stocks, as well as for monitoring trends over time should be developed. For example, it is recommended that animal-based welfare outcome indicators related to feather and injury scoring should be developed and used to assess the level of damage related to aggression during mating, competition for feed and spiking (replacement of old males by young mature males in the flocks).

Broiler breeders have a need for a physical environment that provides comfort and security. Perches may be a component of this and they should be provided at an early age as it increases the chances of meeting the behavioural needs of the birds as well as promoting learning to perch and using raised nest boxes. Sufficient perch/platform space should be provided during rearing so that birds learn to navigate in a three-dimensional space and later during the production period to provide space for all those birds that use them. Even if low percentages of broiler breeder parent and grand-parent stock in Europe are housed in cages, the cages shall fulfil the same requirements for litter, nest box and perches as agreed upon for laying hens. Environmental enrichment has been shown to be beneficial compared to barren environments. In general commercial farms do not use any environmental enrichment and more research is needed on the practical application of environmental enrichment e.g. cover panels, for broiler breeders on European production farms.

In broiler breeders, there is no systematically collected data on health issues such as leg disorders and contact dermatitis, so their exact prevalence is not known. Even though leg weakness is not commonly observed due to the feed restriction, the same musculoskeletal lesions as those observed in broilers have been reported in broiler breeders. The prevalence of leg weakness and contact dermatitis could be monitored using modified versions of the standardised scoring systems developed for broilers. There is also a lack of surveillance data for many infectious diseases. However, deviations from normal water and feed up-take (time, pattern and amount) are interpreted as the first indicators (early warning) of possible disease.

Some birds are culled on farm during the rearing and production phases, for selection reasons (birds not laying or reproducing) or because they are sick or injured. At the end of the production period (60-65 weeks of age), the remaining birds are usually caught, crated and sent for slaughter at commercial slaughterhouses. In some cases, male breeders are not slaughtered but culled and discarded. Transport crates (size and height), should be designed, and slaughterhouse facilities equipped for adult broiler breeder birds (parent stock). If slaughter methods are not adapted to the higher weight of the birds, welfare problems are likely to occur e.g. shackling may injure the birds and there may be inadequate electro stunning due to incorrect voltage and current. Training for those who cull broiler breeders should be put in place and recording animal-based welfare outcome measures, such as number of birds dead on arrival at the slaughterhouse, should be introduced.

In the risk assessment, the probability of exposure to a hazard and the magnitude of the effects (consequences) of that exposure were estimated. Four parameters were scored to assess the importance of a hazard, these were the intensity of the adverse effect that the hazard causes, the duration of the adverse effect, the probability of an adverse effect given exposure to a hazard and, finally, the probability of exposure to the hazard. The top five overall hazards according to risk scores were identified as barren environments, high stocking density, fast growth rate, feed restriction and low light intensity. These five hazards were ranked highly either because the adverse effects are intense and/or prolonged, and/or the probability of the birds being exposed to these hazards is high and the probability of experiencing adverse effects when exposed to these hazards is high. A hazard's risk score ranking does not necessarily correlate with its welfare impact or magnitude ranking (although there is reasonable similarity between the risk score and welfare impact profiles. The magnitude and welfare impact scores for the categorical groups (production and rearing, males and females, fast and slow growing) of broiler breeders were estimated. The trend in the top five for these different categories were similar, despite the groups being chosen specifically because of their differences. In the assessment process greater uncertainty was identified in the conditional probability of exposure than intensity. This is likely to be a true reflection of knowledge in the field as there is relatively more information available describing adverse effects; their intensity and duration, than there is quantifying how extensive the problem is.

It was recognised by the experts that probabilities vary from region to region, country to country and between different types of farming system and so probability estimates consequently had large ranges. Routine data collection across Europe would help to make these estimates more accurate and this is recommended.

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The Community Action Plan on the Protection and Welfare of Animals has as one of the main areas of action "upgrading existing minimum standards for animal protection and welfare as well as possibly elaborating minimum standards for species or issues that are not currently addressed in EU legislation".

Council Directive 2007/43/EC[5] laying down minimum rules for the protection of chickens kept for meat production calls for the Commission to submit to the European Parliament and to the Council a report concerning the influence of genetic parameters on identified deficiencies resulting in poor welfare of chickens.

The report of the Scientific Committee on Animal Health and Animal Welfare of 21 March 2000 on the Welfare of Chickens Kept for Meat Production (Broilers) concluded that a wide range of metabolic and behavioural traits in broilers has been changed by selection practices. It seems that many welfare problems in broilers emanate from the way the animals and the parent stock are bred. In particular, major concerns for animal welfare are the metabolic disorders resulting in leg problems, ascites and sudden death syndrome and other health problems. Genetic selection practices might as well influence resistance to stress. The report also concluded there are also welfare concerns about the way broiler breeder birds themselves are kept in particular with regards to feed and space restrictions.

Terms of reference as provided by the Commission

The Commission therefore considers it opportune to request EFSA to assess all the scientific and commercial information available on the genetics of broilers as well as on the welfare of grandparent and parent stocks and then to issue two scientific opinions, the first one on the influence of these genetic parameters on the welfare and the resistance to stress of commercial broilers and the second one on the welfare of grand-parent and parent stocks raised and kept for breeding purposes.

It is preferable to carry out the assessments in two steps.

As a first step of the mandate, all data available worldwide on genetics either from scientific studies or from stakeholders and breeding companies should be collected and assessed. Furthermore, the data on the welfare aspects of the management and housing of the grand-parents and parents stocks raised and kept for breeding purposes should also be collected and assessed. Account should be taken of the results of the research project entitled "Broiler breeder production, solving the paradox" as well as of the new scientific development in this area. The above mentioned scientific and commercial data should be assessed by 28 February 2010.

As a second step and considering the Scientific Report provided from the data collection, two parallel Scientific Opinions, adopting a harmonised approach, should be developed:

- to assess which elements of broiler breeder bird selection have an impact on the welfare of commercial broilers and on their resistance to stress. Recommendations on how negative impacts could be minimised through different selection criteria should be issued.

- to address the welfare aspects of the management and housing of the grand-parent and parent stocks raised and kept for breeding purposes.

[5] Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production (Text with EEA relevance). OJ L 182, 12.7.2007, p. 19–28

ASSESSMENT

1. Introduction

Over the second half of the 20th century, chicken meat has become a major source of animal protein in the human diet. During this period, the growth rate of commercially-produced broiler chickens has been greatly increased: standard broiler chickens now reach 1.5 kg body weight in 30 days whereas 120 days were needed in the 1950s. Simultaneously, the feed conversion ratio (the amount of feed eaten per kg of chicken growth) was reduced from 4.4 to 1.47. It has been shown that this improvement is largely the result of genetic selection (Havenstein et al., 2003). Broiler breeding is a dynamic process of chicken populations that gradually change the various traits of interest. Traits that initially were of no interest may, after a while (some years), start to change in an antagonistic way due to an unfavourable genetic correlation (e.g. leg disorders, metabolic diseases) causing the breeding company to include that new trait in the breeding index. Selection for fast early growth rate has resulted in major changes in the anatomy and physiology of broilers, and led to various welfare problems (SCAHAW, 2000; Bessei, 2006). This dynamic selection process means that observations done 10 years ago may not be completely relevant today. Welfare implications of the housing and feeding of broiler breeders are also important issues (Decuypere et al., 2006; Renema et al., 2007). It is generally accepted that most of the welfare problems are caused by genetic factors, environmental factors and interactions between them. Research on animal-based (outcome) indicators of animal welfare is making it increasingly feasible to assess welfare and to monitor changes over time. Thus it may be possible to evaluate the consequence of breeding strategies on broiler and broiler breeder welfare and so analyse trends.

Approximately 60-70 % of the world broiler breeding is conducted by European companies and the demand for their products from outside Europe is increasing (see Appendix A). Breeding companies provide lines for the various types of broilers needed worldwide and only very few companies supply the world with broiler breeders and broiler chickens. They have therefore the opportunity to influence the welfare of all broilers through genetic selection, both on welfare and robustness as well as productivity.

2. Scope and objectives

The scope of this Scientific Opinion focuses on the breeding stock used to produce standard meat producing chickens that typically weigh approximately 2.5 kg by 42 days of age (i.e. broilers).

The present Opinion addresses the welfare aspects of housing and management of broiler breeder stocks.

This Opinion is laid out as follows. Chapter 3 describes both husbandry and management aspects during hatching, rearing and production through to slaughter of the breeding stock. Chapter 4 looks at the welfare aspects of husbandry and management, including biosecurity and hygiene. In Chapter 5 some practical welfare indicators are described. Chapter 6 presents a risk assessment identifying the hazards and evaluating the consequences of exposure to such hazards. Finally, conclusions and recommendations are given.

Two *ad hoc* expert working groups were established in response to the request from the Commission to prepare this Scientific Opinion and they have worked in close cooperation. The Working Groups have also made use of technical hearings with experts from the breeding industry[6], information

[6] The Working Group directly received information from Anne-Marie Neeteson (European Federation of Farm Animal Breeders, EFFAB), Mark Cooper (Cobb), Yves Jégo (Hubbard), and Ken Laughlin (Aviagen) as hearing experts

provided by stakeholders and collected by EFSA[7], as well as outcomes from a systematic review of the literature[8].

The lack of published data in some aspects of the question was, in part, compensated by information supplied at the technical hearings. Although this information could not be verified according to the normal scientific standards of peer reviewed publications, the working group decided to use industry based information in this report to make it more complete and comprehensive.

3. Housing and management of broiler breeders (parents and grandparents)

The following sections set out a general description of the housing and management of broiler breeders (parents and grandparents) in EU member states. However, the health and welfare consequences are further discussed in Section 4.

In general, parent stock management manuals (Cobb, 2008; Hubbard, 2009a; Aviagen, 2009) supplied by the breeding companies are used as guidelines when constructing houses or establishing management practices for breeder flocks (Laughlin, 2009). Nevertheless, aspects such as national legislation, regional climate or local traditions will lead to some specific differences between countries and companies. The main part of this chapter refers to parent stock although most of it is also applicable to grandparent stock; differences specifically related to the housing and management of grandparent stock are mentioned in Section 3.9. The figures mainly concern the standard fast growing genotype, and there is a specific Section (3.8) dedicated to medium to slow growing alternative breeds.

3.1. Hatching

At the hatchery, chickens that will become parent and grandparent stock undergo several procedures before they are transported to the rearing farm. First, a selection takes place in which the good quality chicks are separated from non-hatched eggs and poorer quality chicks, and then the chicks are sexed by vent-sexing. Male chicks from the female line and female chicks from the male line are separated from the other chicks (i.e. female chicks from the female line and male chicks from the male line) that will go to the rearing farm. Weak, malformed or rejected chicks are culled, commonly using CO_2 gas or instantaneous mechanical destruction. Chicks are vaccinated against Marek’s disease and in many countries also against infectious bronchitis and Newcastle disease. Finally, the chicks are transported as day-olds to the rearing farm.

3.2. Mutilations

Various mutilations are carried out depending on the country (national legislation), customer request, local tradition and the specific hybrid. In many European countries the toes of male chicks are clipped (which can be the toe that points backwards or inwards) and the males of some lines or crosses are de-spurred (ref. technical hearing). De-spurring as well as toe clipping are done to decrease the risk of skin damage to other birds. It is performed by thermo-cautery, i.e. pressing the spurs briefly against a hot wire or blade, which stops the spurs growing and effects haemostasis. This is performed at the hatchery by trained personnel. De-spurring is not a universal breeder recommendation and there are no figures available on what proportion of male breeder stock undergo this procedure, but it is extremely variable. De-toeing is carried using a hot blade or hot wire, at the hatchery, using the same method as described above for de-spurring. Most parent stock males undergo de-toeing, although the proportion may vary considerably between locations (ref. technical hearing).

[7] European Food Safety Authority; Public call for data on health and welfare aspects of genetic selection of broilers. EFSA Journal 2009; 7(12):1439 [195 pp.]. doi:10.2903/j.efsa.2009.1439. Available online: www.efsa.europa.eu

[8] Lefebvre D, Tatry MV, Shepers F, Rodenburg BT, Huneau-Salaün A, Allain V, 2010. Toward an information system on broiler welfare: Genetic selection Aspects (TOGA). Technical report submitted to EFSA. Available at: http://www.efsa.europa.eu.

Toe clipping can also be applied in broiler breeders for identification purposes, using the same technique as described above. The purpose is to permanently identify day-old chicks and maintain the same marking for mature birds. The procedure is only used for grandparent chicks, and can be applied to both male and female birds. For male birds, this means that if toes 4 and/or 5 are clipped to prevent injuries to females during mating, one additional toe is normally clipped to be used as a genetic identification. In total, this type of toe clipping is applied to a very small number of birds (ref. technical hearing) but here are alternative methods of identification.

Comb dubbing may also be carried out on male broiler breeders using scissors, at the hatchery. This is not a breeder recommendation, and it is estimated that fewer than 10 % of males undergo this procedure, and only upon customer request (ref. technical hearing).

The majority of male broiler breeders are beak trimmed but it is also commonly done in female birds. This mutilation can be applied to one or both sexes depending on the country and local situation. When the infrared method is used for beak trimming (Henderson et al., 2009) this is carried out at the hatchery (e.g. Germany and UK). When other methods are used for beak trimming, such as a hot or cold blade (Henderson et al., 2009) it may be done at the farm. The age at which beak trimming of broiler breeders is carried out varies, but it is usually carried out before the birds are 7-9 days old, although there are cases when it is carried out later, up to two weeks of age. The tendency is towards using the infra-red method, and 2 large breeder companies are offering this service at the hatcheries, which also makes it more consistent as it is then carried out by very experienced staff (ref. technical hearing).

At the hatchery, birds are sexed, commonly vaccinated and may undergo one or more mutilations at this time.

Quantitative information on the frequency of mutilations is not available.

3.3. Rearing period

3.3.1. Housing during the rearing period

From day 1, when the birds are placed in the house, until 16-21 weeks of age when they are transferred to the production unit, they are kept in single-sex groups. The standard group size during rearing is 2,500-3,000 birds. There can be several such pens in the same house, resulting in a total of approximately 10,000-30,000 birds per house or farm.

The standard broiler breeder rearing unit houses in Europe are mechanically ventilated and window-less (Hocking, 2004). However, some houses will have windows and in at least one member state (Sweden) this is a legal requirement. The walls and the roof are insulated and the floor is concrete. The houses receiving the day-old chicks will have heating, to provide a suitable environment for the young birds. Whole-room heating is used in many countries. The temperature is adjusted to approximately 30 C on day 1, and then is gradually decreased to 18-22 C. Similar temperature ranges apply to zonal brooder systems, i.e. systems based on using local heaters in restricted areas of the building, although temperatures directly under brooders can be somewhat higher. In some countries, in particular in Eastern Europe, they are also reared in open-sided houses.

For rearing broiler breeders, litter is usually used on the entire floor area, i.e. no slatted floor area is provided. This means that there is no manure removal during the 18-20 weeks that the birds are kept in the rearing unit. Instead, the manure becomes an integrated part of the litter. The litter material used is often wood-shavings, peat or straw, but other materials are also used. Maintaining a dry, good litter condition is important, as wet litter increases the risk of microbial diseases, and skin problems such as contact dermatitis (e.g. foot-pad dermatitis and hock burn). Adequate ventilation is therefore essential. A very small number of farms in Europe use multi-tier battery cages for rearing broiler breeders, but this cannot be regarded as standard practice.

Breeding companies recommend that perches are provided in the female groups, to accustom the hens to different levels, and for them to develop a sense of balance and to learn how to jump in order to facilitate nesting behaviour later (Estevez, 2009). In many countries raised platforms – instead of perches – are used for this purpose usually from 3-6 weeks of age. Sweden requires perches from day one.

The health of the broiler breeders has the potential to affect the health of large numbers of commercial broilers and so, in order to provide healthy chicks for production, it is considered crucial to manage the broiler breeder environment to be as disease-free as possible. Biosecurity, hygiene and disease control are essential criteria in the design of broiler breeder houses and their management.

Water is generally supplied automatically by nipple drinkers, bell drinkers or cups. The feed, which can be pelleted except for during the first few weeks when crumbs or mash is fed, is provided on feeder tracks or pans or scattered on the floor, commonly using so called 'spin feeders' for pelleted feed, to encourage uniform feed intake (Hocking, 2004). However, mash feed may also be used during the entire rearing period. Spin feeding can be seen as a type of environmental enrichment as it encourages foraging behaviour. The feed is evenly distributed to minimize competition due to feed restriction (see below). When spin feeders are used, one feeder can normally cover up to 2000-2500 animals.

From day one to approximately 18 weeks of age, young broiler breeder birds are kept in single-sex flocks of about 2,500-3,000 birds. Such houses are often window-less, mechanically ventilated, insulated and heated, although in some regions the houses are open-sided. The floor is covered with litter. Raised platforms or perches may be provided. Biosecurity requirements are high.

Cage-rearing of broiler breeders is rare.

Overall, there is a lack of quantitative data on what husbandry and management systems are used in Europe.

3.3.2. Management during the rearing period

3.3.2.1. Record keeping

As with any type of animal production, broiler breeder stockpersons keep records of their birds and any events occurring during a production cycle. Such records will normally include information on the number of chicks placed on day one, the origin of the chicks and the age of their parents. Furthermore, it will include data on growth, water consumption, feed consumption and feed type, daily mortality, including birds found dead, and birds culled, and sometimes the cause of death. Records include data on interventions such as vaccinations, mutilations and medical treatment of the flock.

3.3.2.2. Stocking density

In most countries, the stocking density of broiler breeder flocks during rearing is not limited by legislation. Instead, the parent stock management manuals supplied by the breeding companies are used as a guideline when stocking density is to be decided. Commonly, densities are 4-8 birds/m^2 (approx 10-21 kg/m^2, males) and 7-10 birds/m^2 (approx 13-19 kg/m^2, females). Lower stocking densities are usually applied in open-sided houses. During the first week or weeks the stocking density – calculated in the number of birds per m^2 – is usually considerably higher, especially when spot brooding is applied. The weight of a broiler breeder hen is approximately 40 g on day 1, and by 18 weeks of age the target weight is 1.8-1.9 kg. The target weight of a broiler breeder male is approximately 2.6 kg by 18 weeks of age.

3.3.2.3. Lighting regimes

With respect to lighting schedules the recommendations from the breeding companies are normally followed, sometimes with minor modifications. Day-old chicks are usually kept under continuous or near-continuous light for the first few days before the lighting programme is started. Commonly, light programmes provide 8 hr light during the rearing phase after the first to the second week of life. After the first week, when relatively bright light (20-100 lux) is used at least in the brooding area, the light intensity is usually 10-20 lux, although one breeder company recommends only 5-10 lux at 20 weeks of age (Cobb Breeder Management Guide – Cobb, 2008 online). During the production stage, light is increased to 40-60 lux in dark-out housing and 80-100 lux in natural daylight (Cobb Breeder Management Guide - Cobb, 2008 online). For non-beak trimmed birds, light intensity is normally not above 10 lux during the rearing period.

For open-sided houses and other flocks with natural daylight, a different approach may be necessary in relation to both day-length control and light intensity. For example a curtain system can be used, or considerably higher light intensity levels and greater variations in day-length have to be handled.

3.3.2.4. Feeding regimes

The amount of feed supplied to broiler breeders during rearing is restricted. If broiler breeders were fed standard broiler diets *ad libitum* during their entire life, like commercial broilers, they would grow too rapidly and become far too heavy to maintain good health before reaching the age of sexual maturity. This would have detrimental effects on their health, their fertility and their welfare (see Decuypere et al., 2006). Hence, feed restriction programmes are applied to achieve set target bodyweights at a particular age (Renema et al., 2007). Males and females follow separate feeding programmes, which is the main reason for housing them separately during rearing (Laughlin, 2009). The possible negative welfare aspects of imposing feed restrictions are discussed below. The most severe restriction usually occurs between 7/8 and 15/16 weeks (De Jong and Jones, 2006). Feed allocations during rearing are about one quarter to one third of the intake of unrestricted fed birds (Mench, 2002). There are a number of different designs of feed restriction programmes. In many parts of the world, so-called ‘skip-a-day’ feeding programmes are still widely used. The reason to use these feeding programmes is that the amount of food supplied on a daily basis is relatively small, and in this way one can be sure that the food reaches all birds when distributed. Usually, birds receive no feed at all on ‘skip’ days, except possibly some scratch feed or grit. The total amount of feed supplied per week will be the same irrespectively of the programme applied, and the amount of feed supplied will be the same on all days when feed is served.

Within the European Union, skip-a-day feeding programmes are often applied; mainly 6/1, 5/2 or 4/3 feeding programmes are seen. In 6/1 feeding programmes, birds receive feed for six consecutive days and then there is one day without feed before six new days with feed, and so on. This means that there is one day without feed per week. In 5/2 programmes, the birds will receive feed on five out of seven days per week, whereas no feed will be served on the remaining two days, which will not be consecutive. For example, these birds may receive feed during three consecutive days, then one day without feed, followed by two days with feed, followed by one day without feed, and then the same scheme is applied again for the following week. In Sweden and UK a daily feeding regime is required. (ref. technical hearing). Scientific experiments have evaluated various types of diets, including ‘appetite suppressants’, diet dilution and/or increasing fibre, to minimize the negative side effects of feed restriction. Different types of restriction programmes, limiting the number of feedings per day and the total time when feed is available have also been examined. In addition, broiler breeder diets are designed to have a lower nutritive density than, for example, broiler feed, and a typical broiler breeder diet for the rearing period will have an energy content of approx 2400-2700 kcal/kg (Hubbard 2009a online, Aviagen 2009, online).

3.3.2.5. Feed types

From day 1, the birds are fed a crumb starter diet *ad libitum* until 2-3 weeks of age. In the beginning feed is sometimes given in small amounts several times a day to encourage eating. A second pelleted starter feed may then be introduced or the birds are transferred directly to a grower feed, and the amount of feed given is limited. Birds are then fed a grower diet until the age of 15-18 weeks when they start receiving a pre-breeder diet. From 15 to 16 weeks of age the amount of feed is increased to support the onset of egg production.

3.3.2.6. Trough space

Initially approximately 5 cm of feeding space per bird is recommended by the breeding companies' manuals (unless spin-feeders are used), from 5 weeks of age this is increased to 10 cm per bird, and from 10 weeks of age 15 cm per bird will be required. To balance the feeding programmes, regular weighing of the birds is necessary to keep a uniform body weight in the flocks. The maximum feed distribution time for track feeders is recommended to be no more than 3-4 minutes. Sufficient feeder space and fast feed distribution is important to ensure bird weight uniformity and to minimise aggression around feeding, and so minimize the risk of injury. It is important that all birds receive their allocated ration of feed.

3.3.2.7. Water supply

For water equipment, one nipple per 8-10 birds is recommended, or 1.5-2.5 cm per bird if bell or trough drinkers are used. In hot climates, more space is required. During their first weeks of life, the birds usually have free access to water during all times later, however, water access may be restricted e.g. turning off the water for a few hours (Hocking, 2004). Water is then available for a couple of hours around feeding time, and possibly also on other occasions during the day. This is done to avoid spillage or excessive drinking (polydipsia) resulting in wet litter (Hocking et al., 1993).

3.3.2.8. Litter

New litter material can be added during the rearing period, if necessary. The used litter is usually completely removed after each batch, and the house is cleaned and disinfected before a new batch enters the house.

3.3.2.9. Health issues

Because of the strict health requirements for broiler breeders, the birds are normally vaccinated against a number of infectious diseases, such as Marek's Disease (MD), coccidiosis, infectious bronchitis, Gumboro disease (IBD), chicken infectious anaemia, avian encephalomyelitis and Newcastle disease. There are regional differences between vaccination schemes, partly related to national requirements or to the disease situation in that area. Vaccination against salmonellosis, for example, is used in many countries but not recommended or allowed in others. Most of the vaccines mentioned are administered via the drinking water or as an aerosol spray; but some are given by injection (e.g. Marek's Disease where the first dose is normally given at the hatchery).

Broiler breeders are often blood sampled from the wing vein under the supervision of an Official Veterinarian before the birds are transferred to the production farm, at around week 17-18, to check for any infection, and to check that the hens have sufficient antibodies to provide passive immunity to their offspring and protection against early infection (Butter and Walter 2009).

3.3.2.10. Mortality and culling

From day-old until they are transferred at 16-21 weeks, the expected mortality, including culling (for leg problems, birds being too small ('runts'), beak deformities after trimming), is approximately 5-7 % for females and 8 % for males (ref. technical hearing). There is also some more focussed culling for example birds of the wrong sex. Sexing errors are commonly seen in 1-2 % of the birds, but not all are detected during the rearing phase; culling can reach 10-20 % for males, but is considerably lower for females.

3.3.2.11. Legislation

Currently, very few EU member states have specific detailed legislation related to the housing and management of broiler breeders during the rearing and/or production phase. The Directive 98/58/EC[9] concerning the protection of animals kept for farming purposes covers requirements for staffing, record keeping and management of sick or injured animals in general, and is applicable to broiler breeders.

Commonly applied stocking densities for broiler breeders during rearing are 4-8 birds/m^2 (males) and 7-10 birds/m^2 (females) respectively.

Specific lighting schedules are used.

Birds are feed-restricted in accordance with set programs throughout rearing to limit growth rate and body weight and to achieve desired levels of fertility.

Beak trimming can be carried out to reduce the damage due to injurious pecking, and birds are vaccinated against numerous diseases.

At the age of 16-21 weeks the birds are transferred to the production farms.

Flock uniformity is considered important as it reduces birds fighting over feed. In this way it helps prevent some birds not getting their intended feed allocation, and becoming even more hungry, as well as birds inflicting injury on each other

3.4. Production period

3.4.1. Housing during the production period

Usually the production period starts between 18-22 weeks of age and lasts until 60-65 weeks of age. Natural mating in broilers, rather than artificial insemination, is common in EU countries. Males and females are transported from the rearing farm to the production farm and housed together in the broiler breeder house. Often the male birds (approximately 1:9 see Section 3.4.2) are placed in the production house a couple of days prior to the arrival of the hens. Common group size during the production period is 3,000-8,000 birds, but it is sometimes lower. Several groups can be kept in the same house, resulting in approximately 10,000-30,000 birds per house or farm. One farm can have one or more houses on the same premises.

As in the rearing period it is considered crucial for the broiler breeder environment to be as disease-free as possible and so biosecurity, hygiene and disease control are essential criteria in the design of broiler breeder houses and management systems.

No comprehensive data are available about husbandry and management systems in Europe, but standard production houses in Northern Europe are window-less and mechanically-ventilated. However, some houses will have windows (a legal requirement in some countries) although the windows are often covered as daylight may conflict with the lighting schedule or to prevent shadows which may frighten birds. Lighting schedules affect reproduction and so all light entering the building has to be controlled in some way. Windows are often present in houses in France and daylight is complemented with artificial light to ensure the lighting schedule. The walls and roof are insulated and the floors are concrete. Whole-room heating is used in many countries. The room temperature is adjusted to approximately 20 C. For example, in Italy, France, Spain and Eastern Europe there are also open-sided layer houses. Multi-tier cage systems are used in a limited number of farms, mainly in The Netherlands, and Germany. In these systems, groups of 60-100 standard hybrid birds are housed per

[9] Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes. OJ L 221, 8.8.1998, p. 23–27.

cage with natural mating. Feed, water, automatic nests and perches are present in a cage but no litter. Less than 5 % of the parent stock in Europe is kept in such systems. A small number of farms, mainly in Southern Europe (Portugal, Spain, France, but also in Poland), have breeder hens housed in non-enriched conventional cage systems, single or group cages, with artificial insemination. Cage housing appears to be used for standard hybrid parent stock, 'mini' hen parent stock and coloured breeds parent stock, with some differences between different breeder companies. In total, approximately 1-2 % of the parent stock in Europe is kept in cages. Whether these birds are kept in furnished cages or in conventional cages (of the type that in the process of being phased out for laying hens because they do not contain a nest box, litter or perch) is difficult to determine. Colony cages (such as the ones used in The Netherlands and Germany) do have nest boxes, males present (natural mating) and perches, but these cages do not have litter and thus are not completely comparable with enriched cages for laying hens.

Usually, houses during the production period of broiler breeders have a litter area and some proportion of the floor as a raised slatted area. About half of the EU farms have one-third of the floor area as raised slats and two-thirds covered with litter. The size of the raised slatted area may vary between 20-60% but rarely exceeds 50% of the total floor area (see Breeder Manuals). The litter material used is often wood shavings or straw. Usually the litter material is removed completely after a production round and the house is cleaned and disinfected before the new flock arrives. Maintaining a good and dry litter quality is essential for keeping the nests and eggs clean so as to protect the health of future chicks. The height of the slats is no more than 60 cm above litter. Nests are positioned on the slats and can either be collective nests with an automated collection belt or individual nests with litter (like wood shavings or straw) and manual egg collection. Collective nests are most common in EU countries. Water is provided on the slatted area. Feed is usually provided in the litter area, or can be provided both in the litter and on the slats. Perches are not very common in production houses, but are required by legislation in Sweden and Norway. An alternative to perches are elevated platforms as used in Sweden. But it is not know how many birds are using perches / platforms and how often. Usually the houses do not have a manure removal system for regular removal of manure during the production period. Instead, there is a deep pit under the slatted floor area where manure collects until the entire house is cleaned after the production round.

Feed, which is either pelleted or mash, is provided on feeder tracks or in feeder pans. Males and females have separate feeding systems. Males are usually fed using feeder pans which are situated high enough so that hens cannot eat from them, whereas grills are placed on the female feed tracks or pans allowing hens to put their heads through but not males which have wider heads. Some farmers scatter grain, grit or oyster shells in the litter in the middle of the afternoon to stimulate foraging and mating behaviour. This can be done either by hand or by an automated system. Water is supplied automatically using cups, bell drinkers or nipples. Bell drinkers are probably still most common but nipples are becoming more popular.

The laying period starts at 18-22 weeks and continues until 60-65 weeks in most cases, natural mating is used.

Birds are normally slaughtered at a body weight of between 4 and 5 kg.

Production houses are often window-less, mechanically ventilated, and insulated, although open-sided houses can be seen in some regions.

A raised slatted area and a littered area are used commonly, no more than 50% of the area being slatted. Nests are provided.

Males and females are fed separately.

Biosecurity requirements are high.

Little data available about husbandry and management systems in Europe.

3.4.2. Management during the production period

Stockpersons keep records of the number of birds placed in the house, the origin of the birds, the age of the birds, and any events. Furthermore, production data are included such as the number of eggs produced, hatching egg numbers, average egg weight and egg mass. Feed intake is recorded, as well as feed type, feed clean up time and body weights (weekly at least until 35 weeks of age, every 3-4 weeks from 35 weeks of age onwards). Water consumption is recorded as well as housing and outdoor temperatures. Mortality is recorded, including birds found dead, birds culled, and sometimes, the cause of death. Records must include data about any medical treatment of the flock; this is an EU requirement (EU General Directive on farm animals 98/58).

The major goals in the management of adult breeders are to maintain the health status of the flock while allowing for a continued, but slow increase in body weight in order to keep egg production at a high level. Major criteria for monitoring birds for management purposes include body weight, body condition, egg production and hatching, hatchability and infertility, egg weight and egg mass (Leeson and Summers, 2000).

Males are selected before transfer to the production house on the basis of body weight (avoiding birds that are either too heavy or too light), feather cover, and body, leg and toe condition. The percentage of males placed in the production house at the age of transfer varies between 8-11 %, with the aim to have a maximum of 7-9.5 % males at 23 weeks of age when egg production starts. The percentage of males is dependent on country and individual farm management.

Male selection continues during the laying period. Important selection criteria are male reproductive activity (non-mating males), extreme body weight and leg condition. Male mortality during the production phase is about 10 % and about 15-25 % of the males are culled due to the selection criteria above.

Female mortality during the laying period is on average 9 % but may vary between 4-12 %. The percentage of hens culled due to selection is about 1-2 % during the production period, making a total mortality of 5-14 %. Mortality in the laying period for parent stock was recorded as 9.5 % and in male and female parent lines ranged from 10-13 % in Europe in a large data set of field records (Hocking and McCoquodale, 2008). In the same paper mortality was shown to decline annually over the previous decade by 0.69, 0.05 and 0.41 % respectively for male-line, female-line (grandparents) and parent stocks at the same time that the production of hatching eggs increased by 0.6, 1.8 and 1.3/year.

During the rearing period, in most countries the stocking density of broiler breeder flocks is not limited by legislation and parent stock manuals are often followed with respect to stocking density. Stocking density in EU countries ranges from 5 to 8.5 birds/m^2 (approximately 20-34 kg/m^2 at 60 weeks of age, based on hen weight). The lowest densities are applied in open-sided houses. The Netherlands has legislation for the laying period that limits stocking density to 7.7 birds/m^2 (approximately 31 kg/m^2) and at least 300 cm^2 litter area per bird, whereas Sweden and Norway has a maximum stocking density of 7.5 and 7.0 birds/ m^2 respectively (approximately 28-30 kg/m^2) during the laying period. Weights increase from about 2.6 kg at 18 weeks of age up to 4.8-5.5 kg at 60 weeks of age for the males, and from 1.9 kg at 18 weeks of age up to 3.5-4.0 kg at 60 weeks of age for the females.

Weight control is important during the laying period and separate feeding is applied for males and females. Feed is not as severely restricted as during the rearing period; however, feeding is carefully controlled during the laying period for both males and females (Hocking, 2009). This implies that birds may be restricted to 45-80 % of the *ad libitum* intake until the peak of lay (Bruggeman et al., 1999) and to about 80 % of *ad libitum* intake after peak of lay (Hocking et al., 2002). Feed is provided daily either early in the morning about half an hour after lights on, or about 5-8 h after lights on. Males should not lose weight but not become too heavy as it has adverse effects on fertility, especially after 30 weeks of age but small weekly body weight increases after 30 weeks of age are necessary to maintain fertility (Hocking, 2009). For the females, the aim is to start the egg production (5%

production) at 23-25 weeks of age. Egg production and body condition determine the amount of feed provided. When the flock reaches 5-10 % production a larger increase in feed is advised until peak production (around 30 weeks of age). After peak production feed intake is decreased slowly to prevent fat deposition and too sharp a decrease in egg production (Hocking, 2009).

Breeding companies advise 15 cm feeder space for the hens and 20 cm feeder space for the males. With pan feeders, the number of males per pan is advised to be 8 and the number of hens 10-12. Feed distribution time is recommended to be three-four minutes. For the water equipment, it is advised to have 60-80 birds per bell drinker, 15 birds per cup or 6 birds per nipple.

Like for the rearing period, water is often not available *ad libitum* but is restricted to prevent over-drinking ('polydipsia') and spilling. In general, water is supplied during feeding until at least two hours after feeding, and during one hour in the afternoon just before lights turn off. It is essential to monitor the water intake of the birds and not to be too restrictive because that will have adverse effects on production and health. In some countries, water access is not restricted at all during the production period.

With respect to lighting schedules the recommendations from the breeding companies are generally followed. Around the age of transfer to the production house the light period increases from 8 hours per day to 15-16 hours light at 28 weeks of age. Light intensity increases to 40-60 lux between 19-21 weeks of age, depending on the age of transfer to the production house. For non-beak-trimmed birds, light intensities of 20-40 lux may be applied. For open-sided houses and houses with natural daylight a different approach may be necessary.

Nests can be either individual nests or collective nests. The industry recommended number of hens per nest is four to five hens for individual nests, or 40-90 hens per metre for automatic collective nests. In general, automatic collective nests are positioned on the raised slats.

Males and females generally become sexually mature between 18-23 weeks of age. It is important that males and females are equally mature to prevent problems with over-mating and aggression towards females, or inactive males. Immature males should not be transferred to the production house. If males are too aggressive towards females, females may become fearful and hide in the nests (Millman et al., 2000) and in that case some of the males are removed and replaced later.

A procedure called 'spiking' is common around 40 weeks of age in some countries, but rarely seen in others. Inactive males in bad condition are removed and replaced by younger mature males, with the objective of maintaining productivity of fertile eggs to the end of the breeding period (Leeson and Summers, 2000). Spiking represents a risk of introduction of pathogens and strict biosecurity conditions are therefore necessary. Introduction of new birds would also be expected to increase aggression.

During the production period the proportion of males decreases (mainly due to selection) from about 7-9% around 23 weeks of age until 6% at 60 weeks of age.

From the second half of the laying period onwards, the feather cover of the hens often deteriorates. This can be due to pecking behaviour but the main factor is the mating behaviour. The quality of the feather cover differs between different types of hybrids. This is a welfare issue for transport, thermal regulation and injury.

Blood samples are taken at regular intervals (every 12 weeks) for monitoring disease. Vaccinations are not as frequent as during the rearing period and in EU countries usually broiler breeders receive vaccinations only against infectious bronchitis during the production period.

Males and females generally become sexually mature between 18 and 23 weeks of age.

Stocking densities commonly applied range from 5 - 8.5 birds/m^2.

Feed is provided daily, although some restriction is imposed.

In some countries, a proportion of the old males are replaced by younger mature males at around 40 weeks of age to improve fertility results, so called 'spiking'.

The percentage of males at the start of the production period is approximately 8-9 %, and decreases to approximately 6 % at the end of the production period, due to selection culling.

3.5. Culling methods

As mentioned above, some birds will be culled during the rearing and production periods. In many cases these are selection culls, where mainly male birds but also some female birds are removed from further breeding. Furthermore, sick or injured birds may be culled for animal welfare reasons.

The main method used for on-farm culling of a limited number of sick or injured birds is manual neck dislocation. In some countries a stunning prior to neck dislocation is required; this is usually carried out by a percussive blow to the head. A percussive blow to the head may also be used to kill and not only to stun a bird. In the EC regulation on the killing of animals (Council Regulation (EC) No 1099/2009 to be applied after Jan 1 2013[10]), manual or mechanical cervical dislocation will only be allowed for poultry up to 5 kg live weight, regardless of whether stunning is used or not. For birds weighing more than 3 kg, which applies to all adult broiler breeders, only mechanical (i.e. not manual) cervical dislocation will be allowed. For male broiler breeders, that may weigh more than 5 kg, other methods of killing will then have to be used. Possible methods for these birds are stunning using a captive bolt gun designed for poultry, or electrical stunning, followed by bleeding to death. Training for those who cull broiler breeders will be needed.

For a detailed description of different stunning and killing methods for poultry, see the EFSA report on animal welfare at slaughter and killing (EFSA, 2004a).

3.6. Transport

In contrast to laying hens, broiler breeders are usually reasonably well muscled at the end of their production period before slaughter, and there is a potential value in the meat from these birds. Hence, end-of-lay broiler breeders are normally sent for commercial slaughter. At the farm the birds are caught manually, as the type of automatic catcher sometimes used for commercial broilers cannot be used in sheds with raised floors. Catching usually takes place at low light levels, e.g. when the lights have been turned out, as birds are calmer in dim light. The birds are then placed in crates, which can be standard broiler crates or crates that are somewhat higher, as the breeders are heavier and taller than a standard broiler. Broiler breeders can also be transported in large containers. The stocking rate in transport crates or modules may be restricted to avoid hyperthermia during transport, especially if standard broiler crates with a relatively low cage height are used, as it is necessary to allow for adequate air circulation and heat dissipation around the birds. Minimum floor area in transport crates for poultry in the EU is regulated by the Council Regulation on the protection of animals during transport (EC 1/2005[11]) and is related to bird total body weight. According to the recommendations from the Council of Europe (N°R (90)6), the height of the crates should be no less than 34 cm for birds weighing more than 4 kg. Broiler breeders are also transported in the same type of crates as mentioned above when transferred from the rearing site to the productions site before start of lay. Some of these points are elaborated in the EFSA Report on Transport (EFSA, 2004b).

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[10] Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing (Text with EEA relevance). OJ L 303, 18.11.2009, p. 1–30.
[11] Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97. OJ L 3, 5.1.2005, p. 1–44.

Finally, the birds are transported to a slaughterhouse. There are rarely specific abattoirs for broiler breeders; instead, these plants can slaughter broiler breeders, spent laying hens, broilers and sometimes turkeys. As some standard broiler abattoirs will not slaughter broiler breeders, they may have to be transported for long distances to reach suitable slaughter facilities.

For a detailed description of poultry transport methods, see the EFSA opinion on animal welfare during transport (EFSA, 2004b).

3.7. Slaughter

The most commonly used stunning method is electrical water-bath stunning, where the birds are shackled by their legs when conscious, suspended and automatically brought to the water-bath stunner. Because the width of the legs will vary between species and sizes of birds, shackles of different widths should be used for the different types of birds so that no excessive force has to be used to place the legs of the birds correctly as this will create a welfare problem for heavy breeders. At some slaughterhouses the male birds are culled and discarded, because of processing problems linked to the differences in the shape of the body cavity, but at other plants they are processed similarly to the female birds. Stunning voltage and current may be too low for the size of the birds. Controlled atmosphere stunning (e.g. two-phase carbon dioxide, argon) is an alternative method that would avoid shackling.

For a detailed description of different slaughterhouse handling and stunning systems for poultry, see the EFSA opinion on animal welfare at slaughter and killing (EFSA, 2004a).

Some birds are culled on farm during the rearing and production phases, for selection reasons (birds not laying or reproducing) or because they are sick or injured. Such culling is usually carried out using cervical dislocation.

At the end of the production period, the birds are usually caught, crated and sent for slaughter at commercial slaughterhouses.

In some cases, male breeders are not slaughtered but culled and discarded.

Transport crates (size and height), slaughterhouse facilities and shackles should be equipped and designed for killing of broiler breeders birds.

Culling training is needed on farms and in abattoirs.

3.8. Medium to slow growing alternative breeds

In some European countries, such as France, dwarf females can be used as parents. They are of two different kinds: the lighter ones being ‘coloured mini-hens’ (as represented in Figure 1) and the heavier ones being ‘standard white mini-hens’. The characteristics of these alternative hybrids are the smaller size of the hens compared with fast growing breeds (see Figure 1). A density of 9 to 10 hens per available m^2 during the rearing period is recommended (see for example the Management Guides for Colour Mini parents or F15 parents from Hubbard – Hubbard 2009b, online). However at the farm level and according to the equipments and the climatic conditions, birds can reach a density of 15 hens/m^2 (22.5 kg/m^2) and 11.5 hens/m^2 (22 kg/m^2) at 20 weeks for coloured and white mini-hens respectively. During the production period, the density is around 9.5 hens/m^2 (plus 10 % males, e.g. 10.5 birds/m^2, 25 kg/m^2) and 8.4 hens/m^2 (plus 9% males, e.g. 9.1 birds/m^2, 30 kg/m^2) for coloured and white mini-hens respectively. Densities presented are calculated with the total surface of the pen (nest included).

The mini-hens are used for several kinds of production (see Figure 1). When crossed with white fast-growing males, the standard mini-hens produce white standard chickens. This type of cross is almost exclusively used in France for the production of the standard chickens. When crossed with fast-growing males, the coloured mini-hens produce white medium growing ‘certified’ chicken. Finally, when crossed with coloured slow growing males, the coloured mini-hens produce slow growing coloured chickens used in France for the production of Label Rouge, organic or "fermier" chickens.

Mini female broiler breeders represent around 98% of the parental stock in France (ref. technical hearing) and 18 to 20% of the parental stock in Europe. Concerning the particular case of the coloured mini-hens, they represent around 30 % of the parental stock in France (around 2.3 million birds) and 7 % of the parental stock in Europe. For the Label Rouge production (which represents about 14% of broiler production in France), both male and female (i.e. mini-coloured hens) breeders have to be chosen within a closed list of authorized hybrids characterized by a slow growth rate (target body weight of 2.1 to 2.3 kg at 84 days of age). Some countries (e.g., Switzerland, Germany and Austria) have a very limited number of production farms with organic broiler breeders (between 2-8 flocks per country).

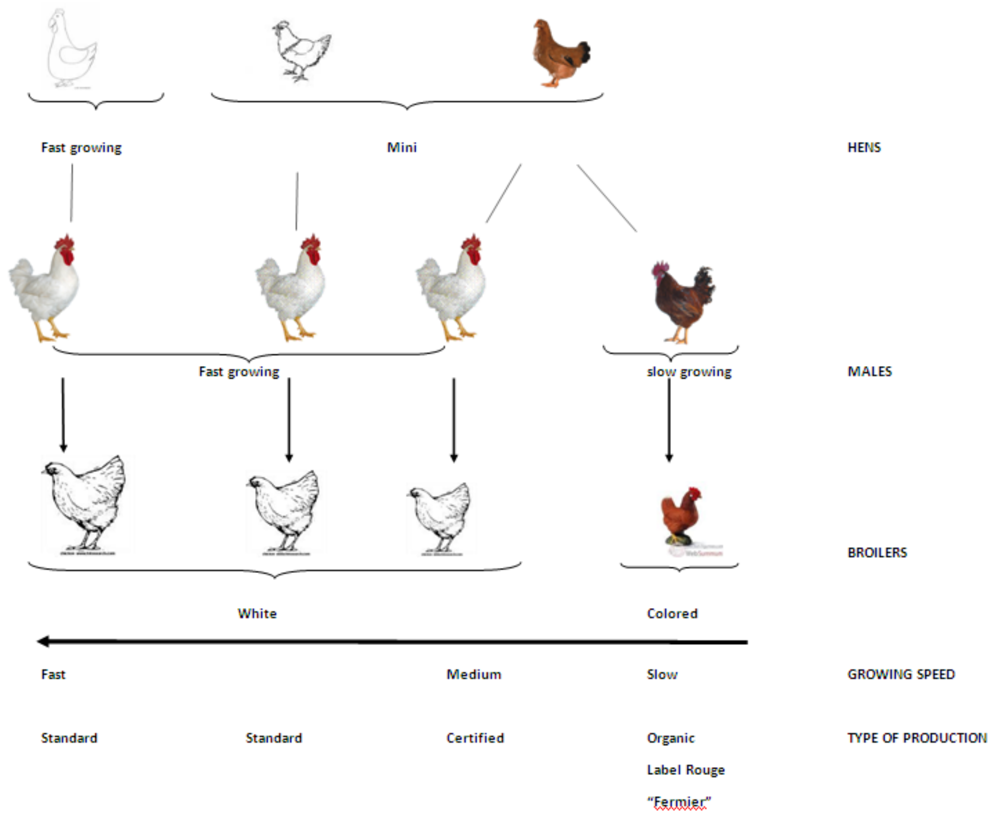

Figure 1: Characteristics of offspring regarding male and female breeder genotypes (fast/slow growing)

Feed is almost unrestricted during the production period for coloured mini-hens and is much less severely restricted for white mini-hens than for the standard 'heavy' breeders (Decuypere et al., 2006). At the peak of lay, coloured mini-hens weigh around 2.1 kg. They are given 120-125g of food per day which is consumed in more than 10 h. At the same period, white mini- hens weigh 2.6 kg. They are given around 145 g of food per day, which is consumed in 4 to 5 hours. As a comparison, normal size standard females weigh 3.3-3.4 kg. They are given 170g of food per day, which is consumed in 2 to 3 hours. During the growing period feed restriction (5/1 or 6/1 feeding programmes) can be applied (Decuypere et al., 2006). During rearing the mortality is about 5 % in mini-females. During the 40 week production period, a mortality of 6 % to 7 % is usually observed, even if higher mortality rates have been reported (ref. technical hearing).

Mini-hens represent 18-20% of parental stock in Europe and the majority of parental stock in some countries such as France.

The main reason for using mini-females is that they are of smaller size and have lower feed consumption.

Their offspring grow slower compared with classical hen offspring, which may reduce health and welfare problems linked with very fast growing birds.

3.9. Specific issues for grandparent stock (grand-parent and parent stock)

Housing and management of grandparents is in general similar to that of the parent stock described above, including feed restriction and mutilations. There are slight differences, like biosecurity which is even more strict compared with parent stocks and they receive slightly more vaccinations. Selection at 4-5 weeks is stronger, but the selection traits are the same. Another major difference is the lower stocking density applied during the rearing and production period. During rearing the stocking density is normally limited to 6 males/m^2 and 8 females/m^2, but during laying the stocking density applied is limited to 6.5 birds/m^2. The mean female mortality to 60 weeks of age in grandparent flock ranges from 7.2 to 13.2 %, depending on e.g. geographical location, the sex of the birds and culling practices applied (Hocking & McCorquodale, 2008). The main reasons for the slightly higher average mortality in grandparent flocks compared with parent flocks are the stricter selection practices and the absence of the heterosis effect otherwise achieved in the offspring when genetic lines are crossed. In some cases, the grandparent stock is kept in cages and artificial insemination is used (ref. technical hearing). Cages may be used for niche market grandparent birds because of the small numbers involved and production-management efficiency. Furthermore, grandparent males can be housed in cages for artificial insemination of females kept on the floor, but this is rare. It is estimated that no more than 2-3 % of the grand-parent stock in Europe are kept in cages. This includes grandparent stock of standard hybrid, mini-hen and coloured breeds. The type of cage used for grandparent stock would mainly be conventional group cages, where artificial insemination is used. However, not all breeding companies are using cages for grandparent stock.

Housing and management of grandparent stock is in general similar to that of the parent stock, but with slightly lower stocking density.

Cage housing can be used for grandparent stock, but is rare.

4. Overview of the welfare of broiler breeders (parent stock)

This section describes current welfare problems encountered in broiler breeders.

There are several differences from laying hens as maintaining a high health status is critical and so monitoring is more intensive (e.g. in vaccination schedules, record keeping, management, blood sampling for diagnosis and infection control). Moreover, treatment of laying hens is restricted because of the controls on the use of antibiotics and there is an additional factor about protecting disease in the offspring as opposed to the breeders themselves.

4.1. Feed restriction

Due to selection for fast growth and high breast muscle yields broiler breeders have a very high food intake when feed is not restricted. However, unrestricted feeding in broiler breeders leads to heavy body weights associated with several pathological conditions, such as lameness and premature death (Mench, 2002), that negatively affect broiler breeder welfare. In the study by Heck et al. (2004) a low viability was observed for standard broiler breeder females fed *ad libitum*, with a mortality of around 40 % at the end of the experiment (40 or 49 weeks of age) while it was estimated at around 6 % for the restricted fed counterparts. In addition, unrestricted fed broiler breeders have adverse changes in ovarian function leading to multiple ovulation and poor fertility during the production period, which is the main reason for applying restricted feeding (Hocking, 2009).

The study by Heck et al. (2004) gives an illustration of the genetic antagonism between growth and reproduction traits by comparing standard broiler breeders fed *ad libitum* with restricted fed birds (the feed intake of the restricted fed chickens was equivalent to 37% of the *ad libitum* fed group up to point of lay). Sexual maturity was delayed by 6 weeks in restricted birds compared with *ad libitum* fed hens that started to lay earlier (around 20 weeks of age). When fed *ad libitum*, the standard broiler line had low egg production (from 22.5 to 52.4 % between 32 and 40 weeks of age according to the experimental facilities) with a high proportion of non-settable eggs and a poor laying persistency. These low reproductive performances were compensated by a feed restriction that resulted in a significant reduction in weight gain.

To maintain good health and good fertility broiler breeders are routinely fed restricted quantities of feed, particularly during the rearing period. Feed restriction is, in general, started at one week age. Feed allocations during rearing are about one quarter to one-third of the intake of unrestricted fed birds. Feed restricted broiler breeders consume their daily ration in as little as 15 minutes during rearing. However, there is substantial evidence that this feed restriction has negative effects on broiler breeder welfare. The consequences of the severe feed restriction include chronic hunger, the performance of abnormal behaviours such as over-drinking, increased pecking at non-feed objects, and increased pacing. For example, feed restricted boilers of two different genotypes subjected to two different levels of restriction spent significantly more time pecking at the litter or at the empty feeder than unrestricted birds (Merlet et al., 2005). These behaviours are characteristic of frustration due to unfulfilled feeding motivation (D'Eath et al., 2009; Mench, 2002). It has been shown in female birds that the proportion of time spent spot pecking increases the greater the level of restriction (Hocking et al., 1996). In addition, elevated plasma corticosterone concentrations and heterophil:lymphocyte ratios in feed restricted broiler breeders during rearing have been interpreted as physiological indicators of distress; but this has not occurred in all experiments (De Jong et al., 2002; Hocking et al., 1993; Savory et al., 1996). Restricted fed birds show a hyperthermic response to feeding which lasts for about 1-2 hours, which is probably caused by high activity levels and an increase in metabolic rate during and after feeding (De Jong et al., 2002). During rearing, feed may be provided every day or skip-a-day feeding programmes may be applied. Behavioural measurements and heterophil:lymphocyte ratios did not show more signs of stress in skip a day feeding compared with every-day feeding (Skinner-Noble and Teeter 2009a). However, research in this area is very limited and more research is necessary to draw firm conclusions about feeding programmes in relation to bird welfare.

Feed is also restricted during the production period but is less than during the rearing period and varies from 45-80% of the intake of unrestricted fed birds until the peak of lay (Bruggeman et al., 1999) when it rises to about 80% of the intake of unrestricted fed birds (Hocking et al., 2002). The birds showed no abnormal behaviour. Stereotyped pecking at non-feed objects, indicative of frustration of the feeding motivation, can be observed during the first weeks of the production period (De Jong et al., 2005b; Zuidhof et al., 1995). Birds that were restricted after peak of lay showed more drinking and stereotyped pecking at non-feed objects at 36, 48 and 60 weeks of age compared with unrestricted fed birds, although the increase in drinking and stereotyped pecking was much less than that observed with food restriction during rearing (Hocking et al., 2002). DEFRA (DEFRA, 2000) designed a study to assess the response of broiler breeders to food restriction and showed higher productivity, less mortality, fewer rest periods, more spot-pecking, preening and drinking for restricted birds compared with *ad libitum* fed birds.

Over the past 30 years broiler breeder body weight targets have undergone small changes, whereas there have been large increases in growth potential. As a result the degree of food restriction needed to maintain broiler breeder body weight targets has increased and this trend is likely to continue (Renema et al., 2007). Dwarf females and mini-hens are almost unrestricted or are much less restricted compared with standard broiler breeders; it has less of a negative impact on bird welfare (Decuypere et al., 2006).

It should be noted that research on the effects of feed restriction on the welfare of broiler breeders has focussed mainly on females. Remarkably little work has been done in broiler breeder males. Males are less severely restricted than females during rearing (Renema et al., 2007) but during the production period the restriction level in males is more severe that in females. The majority of research on the effects of feed restriction on behaviour has focussed on small groups of birds in an experimental setting. There is evidence that the behaviour of restricted broiler breeders during rearing in large commercial flocks is different from that in experimental flocks in small pens, but this needs further research (Hocking and Jones, 2006).

More recently, research has focused on the development of alternative feeding strategies to reduce the negative effects of feed restriction on bird welfare while maintaining the desired growth rate. The benefits of these diets are controversial. They may result in more normal feeding behaviour and promote satiety, but on the other hand 'metabolic hunger' still remains (D'Eath et al., 2009). Diet dilution using increased fibre content of the diet reduced stereotypic object pecking in some studies (De Jong et al., 2005b; Hocking et al., 2004) but not in others (Hocking, 2006; Jones et al., 2004) and it is thus unclear if diet dilution may benefit broiler breeder welfare. A combination of a chemical appetite suppressant (calcium propionate) and oat hulls seemed to be more promising as not only was stereotypic pecking virtually absent but also the time spent sitting significantly increased (Sandilands et al., 2005; Sandilands et al., 2006; Tolkamp et al., 2005). However, Savory et al. (1996) found that only the stereotyped behaviour was absent and the other indicators of welfare were not affected. Such suppressants may have their effect by causing the bird to feel ill and, as a consequence, have a reduced appetite. In commercial practice these alternative feeding strategies are not used and a chemical appetite suppressant may not be acceptable to consumers or farmers (Hocking and Bernard, 1993).

Feeding broiler breeders with a spin-feeder that scatters the feed in the litter promotes foraging behaviour but it did not reduce physiological or behavioural indicators of hunger or frustration of feeding motivation (De Jong et al., 2005a)

As is clear from this section, almost all of the work on animal-based indicators of welfare related to feed restriction has been carried out under experimental conditions. The potential animal–based welfare indicators of hunger e.g. stereotyped spot pecking, over-drinking and physiological measures are not sufficiently validated for use in practice.

There is a genetic component as the degree of restriction necessary e.g. for mini-breeders it is lower than for standard broiler breeders.

The degree of restriction has been increasing over the past few decades in response to selection for higher growth rates.

Not restricting the feed will cause welfare problems because of the high body weights of non-restricted standard birds including increased premature death.

The degree and duration of feed restriction causes welfare problems associated with hunger. There is a lack of data on the effect of feed restriction in broiler breeder males as most research has been on females

Alternative feeding strategies, like diet dilution and appetite suppressants, do not clearly benefit broiler breeder welfare

The trend in the degree of feed restriction required to maintain broiler breeder bodyweight targets should be monitored.

4.2. Aggression

During rearing, the severe feed restriction causes increased competition around feeding time. In the week following the onset of restriction, restricted fed males are more aggressive compared with non-restricted males (Mench, 2002; Jones et al. 2004; Hocking and Jones, 2006). Aggression around the feeder has also been reported in female broiler breeders during rearing (Hocking and Jones, 2006). Aggression around the feeder may lead to injuries to the birds.

Inadequate management may lead to males reaching sexual maturity earlier than females. This can lead to forced copulation, resulting in distress and injury in the females. As a consequence, females will prefer to stay on the raised slatted area or hide in the nests while the males stay on the litter area (Leone and Estevez, 2008). Notwithstanding differences in sexual maturity, broiler breeder males may display aggressive behaviour towards females, mostly during the performance of sexual behaviour. Courtship behaviour was virtually absent (Jones and Prescott, 2000; Millman et al., 2000; Hocking and Bernard, 2000; De Jong et al., 2009) and sexual behaviour of males has been described as "rough", with males pecking and chasing females and forcing copulation. The rough sexual behaviour caused females to have severe wounds on the back of their heads where males had pecked and grabbed them with their beaks, and also on their body and under their wings where the male's claws ripped the skin during forced mounts (Duncan, 2009). Such rough male mating behaviour may lead to fear in females and be one of the reasons why females stay on the slatted area and hide in the nests; this has negative implications for female welfare. This rough mating behaviour of the males could not be explained in terms of a general higher level of aggression due to feed restriction in broiler breeder males (Millman and Duncan, 2000a; Millman and Duncan, 2000b). It has been suggested that there is no relationship between the level of aggression in general and the performance of rough male mating behaviour (Millman and Duncan, 2000b). Cooper (2004, 2009a, b and c in EFSA 2009, answer to the public call for data) indicated that mating aggressiveness is to be one of the selection points for breeders, and such a trait can be positively linked to traits such as fertility. Jones et al. (2001) showed that UV enriched light improved mating behaviour and the proportion of successful mating in broiler breeders. The effects of stocking density during rearing and laying on (development of) mating behaviour are currently under study (De Jong, pers. comm.).

Artificial insemination is used very occasionally and only in specific breeding lines. However it is no solution to avoid rough mating behaviour. The birds have to be cage housed, which will have negative effects on bird welfare (Section 4.10 on cage housing) and it involves a short period of restraint, which is likely to cause some distress.

To improve fertility of broiler breeders 'spiking' i.e. replacing some of the older males with younger ones is a common practice in some countries (Leeson and Summers, 2000) but despite the positive effects on fertility, spiking may also lead to increased aggression between males and increased forced copulation of females that can result in an increase in injuries to both males and females.

Behavioural observation of aggression is unlikely to be feasible as an animal based welfare indicator, but there are several schemes developed in laying hens to score injuries resulting from aggression e.g. pecks on the comb and/or wounds on the skin, that could be adapted for use in breeding birds (Laywel, Welfare Quality).

Feed restriction causes increased competition around feeding time in males and females which can lead to aggressions and injured birds.

The rough mating by males is a welfare problem for the female birds, but the extent of injury and its prevalence are unknown.

Aggression by males during mating is influenced by management but genetic selection could be used to reduce it.

It is important that during the production period when males and females are housed together that the males do not reach sexual maturity earlier than females.

4.3. Mutilations

In some countries mutilations such as beak trimming, de-toeing, de-spurring and comb dubbing are standard practices in broiler breeder management in order to avoid injuries but sometimes they are carried out more as a matter of habit and routine management practice. There are few data on the prevalence of each mutilation in various countries. It is unclear as to whether they are necessary as well as their effectiveness, and what the consequences are for the birds in terms of their welfare. Birds are sentient and can experience pain and distress and the tissues affected are well innervated. Moreover, these surgical procedures are carried out without any anaesthetic and without any post-operative analgesia and it is very likely that the birds will feel pain. However, practical strategies to relieve the pain and subsequent discomfort have yet to be developed.

Although mutilations may have a negative effect on broiler breeder welfare, not mutilating the birds may also lead to reduced welfare, especially in the females. Beak trimming in broiler breeders is carried out to reduce the incidence and severity of feather pecking and cannibalism. In addition, it is carried out to protect the females from injuries when the male grasps the nape of the hen during mating (Gentle and McKeegan, 2007; Henderson et al., 2009). De-toeing and de-spurring are carried out to prevent feather and skin damage and wounds in the hens due to mounting of the male, especially on the back and on the torso beneath the wings. De-spurring may also reduce damage to the males resulting from fighting.

4.3.1. Beak trimming or partial amputation of the beak

Males as well as females (but more often for males) are beak trimmed either at the hatchery or during the first 10 days of life. Beak trimming is carried out to reduce the incidence and severity of feather pecking and cannibalism, but also to prevent the female from injuries caused by mating. The majority of published research has focused on the effects of beak trimming on the welfare of laying hens, however, it can reasonably be assumed that the welfare implications of beak trimming for broiler breeders are the same. The procedure may involve acute distress from handling, and pain and distress from performing the beak trimming procedure. In addition, it deprives the bird from important sensory feedback from its beak. It can have harmful neuro-anatomical consequences: although tissue damage is repaired the sensory receptors are not replaced, and neuromas may be formed and may become a source of chronic pain. However, there is some evidence that if the procedure is performed in young birds (less than 10 days of age) neuromas are not formed (Cheng, 2006; Hughes and Gentle, 1995).

A few studies have specifically focussed on the effects of different beak trimming methods in broiler breeders. Gentle and McKeegan (2007) compared the effects of automated infrared treatment at one day of age, hot blade trimming at one day of age, and hot blade beak trimming at seven days of age, using no beak trimming or sham trimming as controls. No significant effects were found on the behaviour of the birds during the first hours after trimming or in the subsequent six weeks. However, birds that were hot blade beak trimmed had a lower body weight until six weeks of age compared with birds that were not trimmed or sham trimmed. Birds that were trimmed with automated infrared treatment at day one had a lower body weight until 21 days of age compared with untrimmed or sham trimmed birds. In another study comparing performance of non-beak trimmed birds with birds beak trimmed with either an electro-cautery device or an automated infrared beak trimming device on the day of hatching, little measurable effect of beak trimming on early performance during the first six weeks of life was found (Henderson et al., 2009). This study stressed the importance of the procedure performed by trained and experienced personnel to prevent negative effects on bird welfare due to acute and chronic pain (Henderson et al., 2009). Laying hen studies comparing the effects of automated infrared treatment at the hatchery and hot blade trimming at the hatchery or farm (between 7-10 days of age) with no beak trimming showed that there was an acute adverse effect of both beak trimming methods. Food intake and time spent eating and drinking were reduced for both methods but these effects disappeared after several weeks and no long term effects on productivity were observed (Marchant-Forde et al., 2008; Dennis et al., 2009). In general, infrared beak trimming seems to be slightly better for welfare compared with beak trimming using an electro-cautery device (Gentle and McKeegan, 2007; Henderson et al., 2009, Dennis et al., 2009), although the opposite has also been found (Marchant-Forde et al., 2008).

4.3.2. Other mutilations

In many European countries male broiler breeders are also subjected to de-spurring and de-toeing at the hatchery to avoid potential injury when the male mounts the hens during mating.

De-toeing is carried out in the males to prevent the females from feather and skin damage due to mating. De-toeing is carried out by using a hot blade or hot wire. Besides the distress resulting from handling and acute pain due to the procedure, de-toeing may also have chronic effects as neuromas may be formed and it may affect birds' perching behaviour. However, these neuromas were relatively small and simple compared with the neuromas found after trimming beaks and it was difficult to predict the welfare implications (Gentle and Hunter, 1988). There are no other studies describing the acute and long-term effects of de-toeing on bird welfare.

De-spurring is carried out in males to reduce feather and skin damage to females during mating. De-spurring is carried out by pushing the spurs briefly against a hot metal surface. It can be expected that the procedure may at least cause distress due to handling of the birds and acute pain due to the procedure, but the acute and long term effects of de-spurring and its consequences for bird welfare have not been studied.

Dubbing of the comb is no longer a standard procedure in broiler breeder males but some customers ask for it. It used to be done to reduce the size of the large male combs, to prevent damage to the comb and (sexual) inactivity of the males (as the very large comb hampered visual abilities of the male), but nowadays combs in male broiler breeders are much smaller. It is done at the hatchery by cutting off the comb with a pair of scissors. Like for de-toeing and de-spurring it can be expected that the procedure may at least cause distress due to handling of the birds and acute pain due to the procedure, but there are no studies describing the acute and long-term effects of dubbing and the consequences for bird welfare.

Since most of these procedures are performed at the hatchery, one would assume that accurate figures on the number of birds subjected to each mutilation would be available and so be a relevant animal – based welfare indicator.

Sometimes mutilations have become routine for traditional reasons and may no longer be required.

The extent to which each mutilation, and the methods used, is carried out in EU member states is not known. Because of its implications for welfare, data on the prevalence of beak trimming, de-toeing and de-spurring and the methods used should be collected as well as studies for their need.

4.4. Environmental enrichment

Perches are often regarded as environmental enrichment for broiler breeders (Estevez, 2009). Raised slatted areas /platforms are often used in broiler breeder houses instead of perches. Broilers breeders have a need for physical environment that provide comfort and security. Perches and platforms may be a component of this but there is insufficient data on the use and design perches/platforms for broiler breeders.

Broiler breeders and laying hens are fundamentally biologically similar. Although genetic selection and body weight may quantitatively affect behaviour, behaviour is similar in a qualitative sense as well is their motivation to perform certain behaviours. Hocking et al. (1993) showed that the time spent on different behaviours is similar for restricted fed broiler breeders and laying hens. Time budgets differed between unrestricted fed broiler breeders and laying hens (Hocking et al., 1993). In the absence of data for broiler breeders it may be assumed that the motivation to perch and the use of perches does not differ much between laying hens and restricted fed broiler breeders.

Perches can be used at daytime for resting, preening and as a retreat for lower ranking birds to avoid aggressive encounters (Cordiner and Savory, 2001). Perches should be provided at an early age to develop the spatial cognitive skills of the birds (Gunnarsson et al., 2000) and so promote the use of perches at a later age. Council Directive 99/74/EC[12], laying down minimum standard for the protection of laying hens states that adequate perches should be provided in enriched cages as well as in alternative systems for laying hens. However, frequent use of perches can increase the prevalence of keel bone deformation and bumble feet, although this will depend on the specific perch design being used (Estevez, 2009). Estevez (2009) stressed the importance of a complex environment during the rearing period. In broiler breeder production there may be a disconnection between environmental conditions during rearing (if no perches or raised platforms are present) and the production phase, which may lead to an inability of birds to find feeders, drinkers and nest boxes, and to navigate the more complex broiler breeder house. Providing broiler breeders with perches or raised platforms at an early age improves their skills to jump, to enter nest boxes and in exploring to find resources, which can improve leg health. In addition, the development of good navigation skills may be relevant for females so that they can move quickly to avoid overactive males during the early production period (Estevez, 2009). Information from Swedish industry shows that when perches and platforms are provided, only a small proportion of birds use the perches at a single time and they prefer platforms while and the majority spend the resting and night resting on the littered floor (Berndtson, 2010).

Environmental enrichment can be defined as programmes serving the purpose of improving the biological functioning of captive animals by increasing behavioural opportunities or by reducing the incidence of problematic behaviours, and are generally presented as changes to the structure and content of enclosed facilities (Estevez, 2009). In poultry, different resources can be provided to avoid a barren environment such as pecking devices, mirrors, balls, strings etc. or bales of straw or wood shavings, with the purpose of reducing the incidence of behaviours such as feather pecking, cannibalism and aggression. In general, commercial broiler breeder farms during rearing and production do not use any environmental enrichment. Hocking and Jones (2006) studied the provision of bunches of string and bales of wood shavings during rearing as a means of decreasing aggression and feather damage. The string bunches were not extensively used, but the bales of wood shavings were attractive. However, there was no evidence that behavioural changes associated with feed restriction, including aggression, were improved by using environmental enrichment (Hocking and Jones, 2006).

It has been shown that vertically placed cover panels in the production house can be used to control excessive mating problems in commercial farms (Estevez, 1999) and thus have a positive effect on female welfare. In a later study it was shown that cover panels also improved reproductive performance in broiler breeder flocks, probably by attracting females to the litter floor and reducing male-male competition for females and over-mating (Leone and Estevez, 2008). It should however be noted that these cover panels were tested at production houses in the USA which may have a different lay out compared with production houses in Europe.

Recording that some form of environmental enrichment is provided is no guarantee that is it used by the birds and so has the desired effect. The main benefits of enrichment outlined above are in reduced aggression and improved leg health. Their use as animal based indictors are referred to in Section 5.

There is a need for more research specifically on broiler breeders as the practical application of environmental enrichment.

There are no data on the prevalence and types of environmental enrichment.

Environmental enrichment is beneficial compared with a barren environment.

Perches and raised platforms should be provided at an early age to meet the behavioural needs of birds and promote early learning to navigate in a three dimensional environment.

12 Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens OJ L 203, 3.8.1999, p. 53–57.

Sufficient perch/platform space should be provided for those birds motivated to perch at night

As cover panels seem to prevent excessive mating in broiler breeders, they should be tested on European production farms.

4.5. Ammonia and dust

During the production period, there is usually a deep pit under the slatted floor area, where manure is held until the entire house is cleaned after the production round. This may lead to high concentrations of ammonia, causing irritation of the eyes and respiratory tract, and thus having a negative effect on bird welfare. Very dry litter may lead to high dust concentrations which can irritate the respiratory tract of birds.

Studies concerning dust and ammonia levels in broiler breeder flocks are rare. Mitchell et al. (2004) found ammonia concentrations between approximately 10 to 20 ppm and dust levels between 2 to 7 mg/m³ in the air of a small broiler breeder keeping system. In floor-keeping systems for laying hens with manure storage under the perforated floor and in broiler barns it was found that ammonia concentrations could increase up to 50 ppm during the manure storing period (Winter et al. 2009b, Saleh et al. 2005, Ritz et al. 2006).

The highest inhalable dust concentrations ranged between 3 mg/m³ (laying hens) and 7 mg/m³ (broiler). It can be assumed that especially airborne dust concentrations highly correlate with the activity level of the birds. Highest levels are regularly found when birds show active behaviours such as wing flapping, running, scratching and dust-bathing. Using low-dust litter materials can be beneficial for air quality regarding dust concentrations but with increasing age of the litter material the proportion of faeces, feather and food particles rises and contributes to higher airborne dust and ammonia concentrations (Winter et al. 2009a). Although high levels of ammonia and dust do have consequences for birds welfare, the levels needed for clinical changes are so high that non-animal-based outcome measures (e.g. ammonia and dust levels themselves) are probably more practical welfare indicators.

4.6. Light

Research in broiler breeders related to light mainly focussed on the relationship between photoperiod and sexual development and reproductive activity (Lewis, 2009). From a welfare perspective the timing of sexual maturation in males and females is important.

It is known that chickens have a well-developed colour vision and have the ability to 'see' in the ultraviolet range. UV-A light is important for poultry to obtain more information from the environment (Prescott and Wathes, 1999). In broiler breeders it has been shown that UV-A enrichment improved sexual selection and mating behaviour (Jones et al., 2001), but more research in this area is necessary.

Data are lacking on the possible effects on animal welfare of light coming in through windows as a complement to artificial light programmes but it obviously has to be managed appropriately.

Dim light is often used as a measure to reduce feather pecking in a flock. Laying hens show a preference for lower light intensities for performing certain behaviours such as resting and perching, but will move to brighter areas for more active behaviours such as feeding, drinking and foraging (Davis et al., 1999; Prescott and Wathes, 2002). Very low light intensities (< 5 lux) may cause eye abnormalities as the functional development of vision may be affected, especially when these conditions occur during rearing. At these very low light intensities hens are also restricted in moving around the house and in jumping between horizontal perches (Taylor et al., 2003). Social communication between hens is also hampered (Kristensen et al., 2009). Because laying hens and broiler breeders are fundamentally biologically similar, it can be assumed that very low light intensity also affect these behaviours in broiler breeders.

In laying hens it has been shown that severe feather pecking frequencies were higher in birds housed in a high light intensity (Kjaer and Vestergaard, 1999). For laying hens it is said that light intensities over 10 lux are avoided to prevent feather pecking (EFSA, 2004a). There is no literature about the relationship between light intensity and feather pecking in broiler breeders or about the prevalence of serious outbreaks of feather pecking in broiler breeder flocks. Broiler breeders are genetically different from laying hens and it is known from laying hens that the risk to develop feather pecking differs between different strains of laying hens (Rodenburg et al., 2008). Pecking at other birds can be observed in broiler breeders during the rearing and production period but at a very low frequency (De Jong et al., 2002, 2005a, 2005b), but it is unclear if this is 'real' feather pecking or stereotyped pecking related to the feed restriction imposed. In addition, it is unclear if feather damage observed in broiler breeders is related to aggression, rough mating or feather pecking. More research is needed in this area.

4.7. Stocking density

Stocking density during the rearing and production period may vary considerably between farms and countries. There is no literature available on the effect of stocking density on broiler breeder welfare, although the effect of stocking density on behaviour, injuries and zootechnical performance in broiler breeders during rearing and production is currently under study (De Jong et al., pers. comm.).

4.8. Contact dermatitis

Wet litter may cause contact dermatitis (footpad lesions, hock burns, breast burn) in broiler breeders. There are no data available on the prevalence of footpad dermatitis, breast burn and hock burn in broiler breeder flocks.

Scoring systems for contact dermatitis in broilers are already well developed (see Section 6.4) and could be used as an animal based outcome indicator also for breeding birds

The prevalence of contact dermatitis in broiler breeders is not known.

The prevalence of footpad lesions, breast blisters and hock burns for broiler breeders should be determined using the methods established for broilers.

Systematic recording could be considered to monitor trends.

4.9. Culling

See also Section 3.5.

During rearing and the production period, birds may have to be culled either because of them failing to meet selection criteria or because they are sick or injured. Culling is usually carried out by cervical dislocation. Culling of heavy birds (especially males) during the production period may be difficult and if not performed properly will have a negative effect on bird welfare. It has been shown that neck dislocation does not always render heavier birds immediately unconscious, hence, stunning prior to culling by neck dislocation is recommended for adult broiler breeders. However, the upcoming EU regulation on animal welfare at the time of killing does not require stunning prior to neck dislocation, not even for heavy (3-5 kg) birds.

Culling of birds, as opposed to letting them die, can be an indicator of improved welfare and health. (EFSA Panel on Animal Health and Welfare, 2010).

There is little data on mortality and culling rates and the methods used.

A systematic recording of mortality and culling rates and methods should be instigated and evaluated as potentially useful indicators of welfare and to monitor trends. In addition causes of death as well as post-mortem findings may provide useful information on the birds' welfare

4.10. Transport and slaughter

See also Sections 3.6 and 3.7.

Broiler breeders are transported to the slaughterhouse at the end of the production period but they are much larger and heavier compared with broilers or spent laying hens, and males are larger and heavier than females. Transporting broiler breeders in standard broiler crates may have negative effects on the welfare of the birds if the crates do not meet the height requirements for the birds, and so crates with an increased height should be used. Furthermore, in order to reduce the risk of hyperthermia the stocking density should be appropriate. Excessive stocking densities may be reflected as an increase in dead on arrival (DOAs). In general there are only a few slaughterhouses where broiler breeders can be slaughtered which may result in long transport distances and, as transport is a stressful procedure, this will have negative implications for broiler breeder welfare (Mitchell and Kettlewell, 2004).

For breeder birds transported for slaughter, poor plumage condition because of feather pecking or mating can result in hypothermia, and even an increased risk of skin injuries (scratches) during transport. Furthermore, shackle width at the abattoir may not be wide enough to prevent musculoskeletal injuries such as hip joint dislocation and tears, and bone fractures. There is no literature available specifically describing the welfare of broiler breeders during transport and slaughter but the same basic principles as for other types of hens will apply. For example, controlled atmosphere stunning will avoid welfare problems to do with shackling and electrical stunning and may be used for broiler breeders (EFSA, 2004a)

Birds that have died between catching and the moment of slaughter will be recorded as DOAs and the number reflects catching, transport, lairage and overall animal health and welfare of the animals. It is commonly recorded in broilers but not always in breeding birds.

Transport methods are often not adapted to cope with the heavier weights and size of broiler breeders welfare problems are likely e.g. crate height and stocking densities.

There are limited data on welfare outcome measures at the abattoir e.g. ‘dead on arrival’ and pre-mortem injuries for broiler breeding birds.

Cage size and stocking density should be appropriate for broiler breeders going for slaughter.

Data should be collected on welfare measures on arrival and before slaughter.

If slaughter methods are not adapted to cope with the heavier weights and size of broiler breeders, welfare problems will be caused e.g. excessive leg pressures during shackling leading to leg fractures and dislocations, inadequate electro-stunning due to incorrect voltage and current, not bleeding-out while unconscious due to recovery of consciousness.

Adaptation of the slaughter hall shackles and killing methods should be made to cope with broiler breeders.

Controlled atmosphere stunning should preferably be used to slaughter broiler breeders.

4.11. Cage housing

A small percentage of broiler breeder parent and grandparent stock in Europe are housed in conventional group cages and artificial insemination is used for breeding. There is no literature on the effect of conventional cage housing on broiler breeder welfare. However, from laying hen studies it is known that conventional cages without litter, perches and nest boxes do not fulfil the behavioural needs of hens and have negative effects on bird welfare. There is not enough space for exercise thus preventing the birds from carrying out behaviours like wing flapping or flying. In addition, nesting is a behavioural priority for laying hens but there are no discrete, enclosed nest sites. Perching, dust bathing and foraging are also very important parts of the birds’ behavioural repertoire and cannot be (fully) performed (LayWel, 2006). Broiler breeders and laying hens are fundamentally biologically similar, and it has been shown that restricted fed broiler breeders and laying hens do not differ in their behaviours (Hocking et al., 1993). It can therefore be assumed that the effects of cage housing on the welfare of broiler breeders do not differ to any significant degree from the effects of cage housing on commercial laying hens, and that the welfare of broiler breeder is negatively affected by conventional barren cage housing. The high value birds place on the provision of litter is illustrated by an experiment where broiler breeders were denied access to litter after they had been given access during rearing. Making litter available again diminished the effects of stress due to feed restriction. Moreover, damage due to feather pecking was reduced and plasma corticosterone concentrations were lower (Hocking et al., 2005). In addition, birds may suffer from distress due to handling because of the artificial insemination applied in conventional cages.

In Europe there are a small number of farms that have multi-tier cage systems (‘colony’ cages) for broiler breeder parent stock during the production period, housing about 60-100 birds with nests, perches and natural mating but without litter. Dust bathing and foraging behaviour, important parts of the normal behaviour of chickens, cannot be fully performed in these cages and the welfare of broiler breeders housed in such cages is likely to be poor.

Cages for broiler breeders do not meet their behavioural needs.

Cages for breeding birds should fulfil the same requirements for litter, nest box and perches as agreed upon for laying hens.

4.12. Leg weakness

The same musculoskeletal lesions as those observed in broilers (tibial dyschondroplasia, femoral head necrosis, bone deformities, ligament and tendon rupture) have been reported in broiler breeders. High mortality in broilers breeders fed *ad libitum* is largely related to culling for lameness in males (Hocking, 2004) and in addition, the thickness of articular cartilage may predispose to joint lesions. However, leg weakness problems are not commonly observed in broiler breeders due to the feed restriction (Mench, 2002). A trembling syndrome was observed in feed restricted broiler breeder pullets that was followed by mortality (Julian, 2005) but this has never been reported elsewhere. In general, skeletal disease in broiler breeders is associated with inadequate control of body weight gain and the prevalence of culling for leg diseases is low when feed is restricted. According to Hocking (2004), ligament and tendon ruptures in males have decreased from 1989 to 1998 but the picture is less clear for destructive cartilage loss. More recent data on the skeletal condition of feed restricted broiler breeders in commercial flocks is required.

Tendon rupture is a non-infectious disorder of broiler breeder females that causes lameness that can be observed in approximately 50 % of all flocks. Between 1 and 5 % of the birds in a flock can be affected usually between the 23 and 35 weeks of life. There is no treatment to avoid pain and suffering, and birds are culled as soon as possible. The cause is unknown.

Leg weakness in broilers is usually assessed by gait scoring and with presumably only minor modification in the descriptions of the categories it could be applied to assess leg weakness in breeding birds.

No recent information is available on leg weakness in the last 20 years.

A gait scoring system should be developed for broiler breeders so that a standardised system can be used to assess leg weakness and to monitor trends. Gait score should be validated so that will reflect the association between lameness and pain.

4.13. Peritonitis and salpingitis

Peritonitis is the commonest reproductive disorder that causes suffering and finally also death. The cause is unknown but may be related to depressed immunity in birds following the rapid rise in concentrations of plasma oestrogen at the onset of lay (Hocking and Bernard 2000). It was said not to be a common problem in SCAHAW report 2000 but it is serious for those that have it and it can reach 1-15 % from the 24th week of life. Pathogens such as *Escherichia coli* and viruses cause the disease. The birds usually die quickly by septicaemia and antibiotic treatment is possible.

4.14. Metabolic disorders

Metabolic disorders such as sudden death syndrome (SDS) are observed in broiler breeder hens and are probably due to hypocalcaemia or hypo-kalaemia (Julian, 2005).

4.15. Infectious diseases

The following diseases are those that are more commonly observed. However, in general, infectious disease is not a major cause of mortality in broiler breeders.

The time, pattern and amount of feed and water up-take are monitored by the responsible stockpersons. Deviations from normal consumption are interpreted as the first indicator (early warning) of possible disease. Broiler breeders are usually owned by large companies which have their own poultry health service and so they can react quickly to try to determine the cause. Necessary treatments of parent flocks are less limited than in laying hens because there are no withdrawal periods for hatching eggs in regard to consumer protection. Therefore, broiler breeder flocks can be treated much faster and with more effective medication in case of disease than laying hen flocks (e.g. where the use of antibiotics is restricted). In addition, in broiler breeder flocks careful and intensive vaccination programmes are applied (Damme K and Möbius C, 2010) which can vary between countries and companies in Europe. Nevertheless, some typical diseases still occur in broiler breeder parent and grandparent stocks.

Navel/yolk sack infections.

Navel/yolk sack infections can occur frequently on a flock level in the first week of life ranging between 1-3 % and losses can reach 1-2 %. The infection is caused by various bacteria, mostly *Escherichia coli* and affected animals may die quickly.

Infection with *Staphylococcus aureus*, *Staphylococcus tendovaginitis*.

Ten to thirty percent (10-30 %) of flocks are infected with *Staphylococcus aureus* and *S. tendovaginitis* between 2 and 20 weeks of age. The diseases caused by *Staphylococcus aureus* usually display sporadic clinical signs and 1-5 % can be chronically affected. The birds probably suffer pain if they are not killed immediately and as there is no effective treatment birds diagnosed with such infections are culled.

Coccidiosis.

Cocciodiosis can occur sporadically between 6 to 21 weeks but this parasitic disease can be treated. Vaccination is also a possible option. However, up to 2 % of vaccinated flocks can still have infected birds. Losses can reach 5 % of birds that show acute or chronic clinical signs.

Infection with *Erysipelothrix rhusiopathiae*.

Erysipelas and other septicaemic diseases are very rare, below 1 % of flocks, mostly from 24 weeks of life. When the disease occurs 1 % of the flock can die each day. The birds die quickly. Treatment with antibiotics is possible, and the disease can be prevented using barn specific vaccines. Marek's disease and various endoparasitic infections are very rare in broiler breeder parent flocks.

4.16. Biosecurity measures, management and organization

Biosecurity measures are important in protecting flocks against the entry of infectious agents. General measures such as reducing transmission pathways (e.g. birds, rodents, beetles) and non-living vectors (e.g. materials, feed, instruments, clothes) can help to reduce the entrance and the spread of infectious agents both within and between flocks. Other biosecurity measures include the following.

- Restriction of traffic of people and transporting in and bringing out animals, feed stuff and equipment as well as manure.
- Where possible, reduced direct contact with animals and providing personal protective equipment, including clothing, gloves or breathing masks when required is helpful.
- Ensuring new animals undergo veterinary inspection, testing and quarantine before entering the farm (if required) and flock.
- Dead (culled or dying naturally) animals are stored in a separate area until removed as soon as possible by specialised companies.
- Restricting contact with rodents, insects and wild birds on the premises.
- Preventing farm cats and dogs having access to the birds.
- Ensuring regular checks of health status of personnel with regard to zoonotic diseases.
- Applying strict cleaning and disinfecting regimes regularly to the animal houses.

Prevention of contamination within farms

All in - all out systems (AIAO) with effective cleaning and disinfection between batches is known to be an effective way to reduce transmission of infectious agents. The AIAO system largely relies on a sufficiently long stand-alone period with no restocking and includes effective mechanical, physical, chemical and/or thermal cleaning and disinfection of the farm production environment.

Control of spread between farms

It is probable that movement is an important factor for transmission of infectious agents between farms. Thus, mandatory monitoring and restrictions on movement of animals is an essential control measure.

4.17. Control options for airborne transmission of infectious agents from farms

Options to control airborne transmission are very similar to common biosecurity measures which are applied at an on-farm level (Hartung, 2005).

In order to avoid airborne transmission of infectious agents farm buildings should be a sufficient distance apart (and also from the residential dwellings, ”safe distances” from neighbouring farms and residential areas). For existing farm buildings technical devices such as biofilters or bioscrubbers can be used in order to reduce or to eliminate bacterial emissions between farms (Seedorf and Hartung, 1999), however, experience with these techniques is still limited.

High biosecurity regimes should be in place on farms and between farms to avoid transmission of infective agents.

There is a lack of knowledge how far infective agents are transported in an airborne state. It is necessary to understand and define “safe distances” between farms.

4.18. Training of stockpersons

Training for general management on issues such as litter quality, ventilation, maintaining the buildings, type and placement of physical structures and effectiveness of environmental enrichment is important. One major animal welfare problem related to culling is the fact that birds that are severely sick or injured are not always detected by staff during routine daily inspections. It is essential that stockpersons are able to recognize adverse states in the bird, and then to cull sick and injured birds humanely so that they are prevented from further suffering. Furthermore, if members of staff have not received proper training in culling, and if they are not informed about the animal welfare consequences of not culling, birds may be left to die, which may take considerable time depending on the type of injury or disease.

Stockperson training should provide, with frequent refreshers courses, up-date practical as well as theoretical general management information including culling methods.

5. Indicators used in practice

In the past decade there has been a change in thinking about indicators. For example, there is now a distinction made between 'input' and 'outcome' indicators, somewhat equivalent to the distinction between 'design' and 'performance' criteria in the building and design industries (Rushen and de Passille, 1992; Blokhuis et al., 2003). A distinction is also made according to what the indicator is based upon, that is to say whether it is a measure of resources, management or taken on the animals themselves (Keeling and Veissier, 2005). Several measures and indicators relevant to the welfare of broilers and laying hens have been identified but there are few, if any specifically developed for grand-parent and parent stocks. Although as suggested previously in this report, several of these measures and indicators can be used in practice for breeding birds. This section gives a brief review of some of the terminology regarding indicators and an introduction to some of the issues that will need to be considered when proposing welfare indicators for grand-parent and parent stocks kept for breeding purposes.

There are several assurance and auditing schemes in place for commercial broilers and some of these voluntary schemes are used for labelling of products based on compliance with animal welfare standards or other guidelines. However, these are not harmonised between Member States and there is little consistency in the thresholds for the different indicators that are monitored. Equivalent assurance or auditing schemes are not in place for breeding birds.

Traditionally, indicators used in practice have been indirect indicators of welfare, describing the housing and equipment (e.g. a loose housing system with a specified amount of feed trough space per bird) or the management of the birds (e.g. how many times per day they are inspected). Hence they are often referred to as resource-based and management-based measures. Both can be considered 'input' measures and because they can be used to reduce the risk of poor bird welfare in the future, they are the type of indicator usually used in animal welfare legislation. But sometimes factors interact in complex ways and, in that case, 'outcome' measures are used in animal welfare legislation (e.g. to specify a maximum allowed level of ammonia in a building). Outcome measures can also be measured on the animals themselves (on-farm or at the abattoir) and it is these animal-based (outcome) indicators of animal welfare that are the main focus of this section of the report. Ideally, inputs should always relate to outcome measures, but some inputs may be there for emergencies e.g. back-up generators. Ongoing re-evaluation of the link between inputs and outcomes is recommended to ensure that they continue to be relevant and valid for welfare.

The systematic recording of outcome measures can be particularly helpful in determining trends over time. If the aim is to monitor the consequences of breeding strategies on welfare then it is important that there is reliable surveillance of those animal-based indicators that reflect the areas of welfare concern influenced by genetic selection. When there is a genetic environment interaction, as is usually the case, then it will be necessary that these animal-based (outcome) measures are monitored in commercial practice. The crucial factors when deciding on an indicator are that it is valid (in that it really says something about the welfare of the bird) and that it can be measured reliably (by different people and under different conditions). If it is going to be applied in practice, it is also necessarily for the measure to be feasible. See Keeling (2009) for information on how these factors were addressed in the Welfare Quality project. See Manning et al. (2007) for a further discussion of key welfare indicators for broiler production and in particular how benchmarking can be used in proactive management.

The potential use of records of mortality, dead on arrival at the slaughterhouse and the post mortem inspection controls carried out at the slaughterhouse, such as contact dermatitis, parasitism and systemic illness are outlined in the broiler directive (Council Directive, 2007/43/EC). The EU funded research project Welfare Quality proposed an assessment protocol for poultry (Welfare Quality, 2009) that uses as much as possible animal-based measures that have been scientifically evaluated with regard to validity, reliability and feasibility (Forkman and Keeling, 2009). The World Organisation for Animal Health (OIE) is currently developing standards and has an *ad hoc* Group on Animal Welfare and Broiler Chicken Production Systems that is also developing a list of outcome measures that could be useful indicators of broiler welfare. Although sometimes expressed differently, the following is a list of most of the animal-based indicators of welfare referred to in those three documents, as well as some additional indicators, that could be collected on farm, at the slaughterhouse or both.

- On farm: mortality, feed conversion rate, growth rate, feed and water consumption panting and wing spreading, huddling, shivering, lameness with gait scoring, qualitative behavioural assessment, spatial distribution of the birds, aggressive behaviour, fearfulness (human avoidance behaviour, responses to novel object), use of nest boxes, dust bathing behaviour and use of litter.

- At slaughterhouse: dead on arrival, pre-stun shock and flapping on the slaughterhouse line clinical signs of disease e.g. emaciation, dehydration, hepatitis, pericarditis, abscesses, septicaemia, wing damage and bruising, broken limbs, dislocation of hip and other joints, carcass quality

- Farm and slaughterhouse: contact dermatitis (footpad dermatitis, hock burns, breast blisters or burns), plumage condition and cleanliness, skin lesions and injuries, comb pecking damage, comb abnormalities, condition of the eyes, clinical signs of parasitic, gut and respiratory disease, leg deformities, keel bone deformations, beak trimming, de-toeing and toe clipping, de-spurring

Several of these, and the scientific studies underlying them, have also been referred to earlier in this report under the various sections. Although most of the research has been with broilers or laying hens, many of these indicators may also be used as indicators of welfare in grand-parent and parent stocks.

In addition to the choice of measure, when a particular measure is taken will influence the result and consideration may be given to taking it at the most critical point in time, in accordance with the approach used in HACCP. How exactly the measure is taken will also influence the results, and whether it is based on a sample of birds or not. If the measure is based on a sample of birds, how these birds are selected is important and will need to be standardized if results are to be comparable. Some of these issues can be demonstrated by taking the indicators; mortality, gait scoring and food pad scoring, as examples.

Mortality can be recorded in many different ways. From a management point of view, and to help identify causes so mortality can be reduced, it may be most useful to record it separately for the different stages in the bird's life e.g. to distinguish between mortality within the first 3 days post hatching, during the main on-farm production period and that occurring during transport to the slaughterhouse. Likewise, even if the aim is to monitor and reduce overall mortality, the number of birds found dead should be considered separately from the number culled, since culling of sick birds is desirable to reduce suffering. Thus mortality is not a straightforward indicator to use in practice, although it can be useful for monitoring trends if the exact way to record it is carefully defined. The measure 'dead on arrival' at the slaughterhouse is a measure of mortality that is increasingly being used in commercial practice.

Another example of an animal-based outcome indicator of animal welfare is that of gait scoring. The Bristol Gait Scoring System (BGSS) has six categories ranging from 0 (normal) to 5 (bird incapable of sustained walking) (Kerstin et al. 1992). There is a modified version of this system (MGSS) (Garner et al., 2002) as well as a three category system (Dawkins et al. 2004). All have been used in commercial flocks. A poor gait may have many potential causes and minor deviations from a perfect gait may not necessarily reflect pain. Therefore, if gait scoring is to be implemented in practice, it would probably be most effective to restrict the scoring to the worst gait scores i.e. 4 and 5 according to the BGSS/MGSS, which are unlikely to be attributable to the body morphology of modern broilers (Corr et al., 2003). Gait scoring is also a measure that is clearly influenced by when the measure is carried out (older/heavier birds are more likely to have a poorer gait than younger/lighter ones) and how the sample of birds is chosen.

Finally, if an indicator is to be implemented in practice, then the long term consequences of implementing the measure should be taken into consideration. The complexity of this is perhaps illustrated using the example of footpad dermatitis. In the short term, incentives to reduce contact dermatitis are likely to lead to improved litter management, which in turn will lead to improved air quality through lower levels of ammonia etc. However, there is some evidence that this trait may be heritable (Kjaer et al. 2006; Akbas, 2009). Genetic selection against footpad dermatitis would contribute to reducing any pain and suffering for a particular bird experiencing contact dermatitis, which is beneficial, but it would also eventually lead to it being a less useful outcome measure of litter management in the building. Such aspects would need to be carefully considered and re-evaluated over time to maximise the welfare benefits.

6. Risk assessment on the impact of housing and management on the welfare of broiler breeders, including genetic selection influences

Risk assessment is a systematic, scientifically based process to estimate the probability of exposure to a hazard, and the magnitude of the effects (consequences) of that exposure. A hazard in animal welfare risk assessment may be defined as a factor with the potential to cause a negative animal welfare effect (adverse effect). Risk is a function of both the probability that the hazard and the consequences (characterised by the adverse effect) occur, and the intensity and duration of the consequences.

Factors which adversely affect the welfare of broiler breeders relating to their housing and management are considered in the risk assessment.

Four parameters were scored to assess the importance of a hazard; the intensity of the adverse effect that the hazard causes, the duration of the adverse effect; the probability of an adverse effect given exposure to a hazard; and the probability of exposure to the hazard. The probability of exposure to the hazard corresponds to the percentage of all birds exposed to the hazard. The consequence of exposure can be assessed by scoring the intensity and the duration of the adverse effect in the individual.

In addition to an overall score for all birds, where possible, parameters were scored separately on the basis of production (fast or slow growing birds), life stage (rearing or production period), and gender (male or female), in order that the risk assessment reflects the underlying differences in these categories.

The risk assessment was based on the following assumptions:

1. All birds within a bird-type category (fast/slow growers, male/female, rearing/production period) exposed to the hazard experienced the same intensity and duration of the adverse effect.

2. In the absence of complete prevalence data by country, it is assumed that (i) all birds in all countries that are exposed to the hazard have an equal probability of experiencing the adverse effect; and (ii) exposure to the hazard is equal for all countries.

3. There is no dependence or association between different hazards, or different consequences. The occurrence of a hazard or consequence does not affect the probability of occurrence of other hazards or consequences.

4. Individual expert opinions are independent and unbiased.

The definitions of intensity and the categories for duration of the adverse effect used for the birds considered in this scientific opinion are in the relevant section of this opinion.

6.1. The risk assessment process

The general risk assessment is in line with the approach previously used in the EFSA welfare reports with some modifications according to the risk question posed. In the following paragraphs the risk assessment process for hazard identification and characterization and the probability of exposure to the hazard are described as well as the way they were scored. Finally the risk scoring process is described.

6.1.1. Hazard identification

The objective of the hazard identification is to identify potential welfare hazards associated with housing and management of broiler breeders (Section 4). The identification was based on a review of the literature and field observations. The adverse effect caused by each hazard is described.

6.1.2. Hazard characterisation

Intensity

The approach taken has been to refer to the level of deviation from an optimal (hazard-free) state. Consequently, intensity ranged over six categories: no deviation from optimal, very small deviation from optimal, small deviation from optimal, moderate deviation from optimal, large deviation from optimal, and extreme deviation from optimal: In addition, an “I don't know” option was offered to experts.

The duration of the adverse effect

The time during which an animal will on average experience the adverse effect was estimated in hours. As broiler breeders live for an average of 65 weeks, this translates to a total of 10,920 hours. The duration of an adverse effect can be longer than the duration of the hazard. The possibility that birds are exposed to hazards in a discontinuous manner, or repeatedly exposed was also considered, by estimating the frequency of repeated occurrences over the course of the birds’ lifetime multiplied by the duration of the adverse effect at each exposure. For example, if a bird performs abnormal behaviour for one hour every day, the duration would be 1 hour*455 days = 455 hours in total over the lifetime of the bird.

Conditional exposure assessment

The conditional exposure assessment is performed by assessing the probability of adverse effects given there has been exposure to a hazard. For example, if there is high temperature and humidity within a house, what proportion of the birds contained in the house will develop post-prandial hyperthermia?

Exposure assessment

The exposure assessment is performed by assessing the probability of exposure to the hazard (or prevalence). For example, what is the probability of being exposed to high temperature and humidity? It is recognised that the proportion of the population exposed to a selected hazard will vary depending on the farm of origin and slaughterhouse.

Uncertainty and variability

The degree of confidence in the final estimation of risk depends on the level of uncertainty and variability for each hazard and its consequences (Vose, 2000). Uncertainty arises from incomplete knowledge and/or when results are extrapolated from one situation to another (e.g. from experimental to field situations). Uncertainty can be reduced by carrying out further studies to obtain the necessary data, however this may not always be a practical possibility. It can also be appraised by using expert opinion or by simply making a judgment.

Variability within a population is a natural phenomenon - given constant, equal conditions for all individuals in a population, there will always be observable differences between the individuals, even when measurements are perfect and we have all the data we could possibly wish to collect. The frequency and magnitude of welfare hazards will inevitably vary between farms and countries and over time, and birds will vary individually in their responses. However, it is not always easy to separate variability from uncertainty. Uncertainty combined with variability is generally referred to as total uncertainty (Vose, 2000).

To assess uncertainty and variability in this risk assessment, each working group member independently scored each hazard and its consequences for the four parameters listed previously and recorded their level of certainty in each attributed score. The certainty scores were used to calculate ranges (minimum and maximum estimates) about the point estimate of each score. If certainty was low, the range around the estimated score was wider than if the certainty was high. Attributed scores from the independent working group members were pooled and for each hazard and consequence, the median score and level of certainty for the group was calculated. Variability between members' attributed scores was interpreted from the minimum and maximum scores given by members of the group for each parameter.

To assess variability within the population, working group members could indicate a range of values for each score to show variability within the population, where such information was available. Variability in the scores attributed between experts was taken into account and used to calculate a range around each of the risk measurements (magnitude, welfare impact, welfare risk).

6.1.3. Risk Characterisation

The scoring process

The scoring process was discussed by the working group in plenary but was undertaken by the individual experts separately. The estimates were based on current scientific knowledge, published data, field observation and experience (as summarised in this report).

Calculation of magnitude of adverse effect

The magnitude of the adverse effect is the product of the scores for intensity and duration.

Magnitude = [intensity/max possible intensity score] * [duration/max possible duration] * 100%

Calculation of conditional welfare impact

The welfare impact of the adverse effect is the product of the scores for intensity, duration, and probability of adverse effect given exposure to the hazard.

Welfare impact = [intensity/max possible intensity score] * [duration/max possible duration] * [Conditional exposure probability/100] * 100%

Calculation of the risk score

All four factors (intensity of adverse effect; duration of adverse effect; probability of adverse effect given exposure to hazard; probability of exposure to the hazard), were included in calculating the final risk score of a hazard. The score for each parameter was standardised.

Risk score = [intensity/max possible intensity score] * [duration/max possible duration] * [Conditional exposure probability/100] * [Hazard exposure probability/100] * 100%

Interpretation of the risk score

Due to the limited amount of quantitative data on many effects of hazards on broiler breeders, the risk assessment is entirely based on expert opinion. The methodology used does not give a precise numerical estimate of the risk attributed to certain hazards; however the output can be used to rank the problems and designate areas of concern, as well as highlight areas where further research is needed.

The methodology assumes that there are no interactions between different hazards and consequences. However, many hazards and consequences are associated, so the calculated risk scores may underestimate the welfare risk of certain hazards that lead to multiple collateral effects and associations with other hazards. Likewise, risk scores may be overestimated if a hazard has many associated consequences, but when some of these are attributable at least in part to the co-occurrence of another hazard. The risk scoring is semi-quantitative. Thus the scores allow a ranking, but the absolute figures are not on a linear scale (e.g. a risk score of 12 should not be interpreted as being twice as important as a risk score of 6).

6.2. Assessment of welfare impact of housing and management of broiler breeders, including genetic selection influences

Table 1 shows the aggregated hazard scores and calculated results of the risk assessment. For a breakdown of the risk assessment calculated by the adverse effects associated with each hazard, please refer to appendix B.

This table shows that the top five hazards according to risk scores are barren environments, high stocking density, fast growth rate, feed restriction and low light intensity. These five hazards are ranked highly either because the adverse effects are intense and/or prolonged, and/or the probability of the birds being exposed to these five hazards is high and the probability of experiencing adverse effects when exposed to these hazards is high.

Note that a hazard's risk score ranking does not necessarily correlate with its welfare impact or magnitude ranking (although there is reasonable similarity between the risk score and welfare impact profiles in Figure 1). This reflects the observation that a hazard's intensity or duration may be high, but the probability of a bird experiencing the adverse effect may be low. In this case, magnitude may be relatively high, but welfare impact or risk score would be relatively low. This is shown clearly in figure 1, where hazards with high magnitude have relatively low welfare impact and risk scores (e.g. inappropriate diet). As the absolute values for each score are not linear, only the relative ranking of the hazards is meaningful. We can see that some hazards, that rank relatively low for magnitude, rank higher for risk scores (e.g. low light intensity) because of the higher probabilities of exposure and of exposed birds being adversely affected by them. Hence by way of contrast, the top five ranking hazards by welfare impact and magnitude are:

Risk Score	Welfare Impact	Magnitude
Barren environments	Conventional cages	Inappropriate diet
High stocking density	Barren environments	Conventional cages
Fast growth rate	High stocking density	Wet litter
Feed restriction	Inappropriate diet	=High stocking density
Low light intensity	Low light intensity	=Overly dry litter
		=High light intensity
		Barren environments

Here we see that barren environments have intense and/or prolonged adverse effects (as reflected in magnitude), with a high probability of birds experiencing adverse effects if they are exposed to the hazard (welfare impact) and a high probability of exposure to hazard also (as reflected in the risk score). By contrast, overly dry litter has a high ranking by magnitude, so its adverse effects may be considerable, but as it ranks rather lower in terms of welfare impact and risk score, we may conclude that the probability of experiencing overly dry litter is relatively low.

In Appendix B, the magnitude and welfare impact scores for the categorical groups of broiler breeders are given. To summarise, Table 2 shows the top 5 ranked hazards (in terms of magnitude and welfare impact) for each group. These tend to vary in only minor ways from each other, despite the groups being chosen specifically because of their differences. The overall top five ranked welfare risks reappear in each of the groups to varying extents. Conventional cages appear as a top ranked welfare hazard for production birds and fast- and slow-growing birds in terms of welfare impact. However, by comparing this with the risk scores (which takes into account the probability of exposure to a hazard), we see that the relative ranking is much lower in terms of the risk score. So although conventional cages may have intense and prolonged consequences, and the probability of experiencing the adverse effects is high if exposed to the hazard, the probability of experiencing the hazard (i.e. of being caged) is low.

Table 1: Median, minimum and maximum expert opinion scores for hazard intensity (scored 0-5, max 5), duration (in hours, max 10920), likelihood of experiencing consequences given exposure to hazard (%), and likelihood of exposure to hazard (%) for the 23 identified hazards associated with environment and housing of broiler breeders. Also provided are the median, minimum and maximum scores for each hazard's magnitude, welfare impact and risk score.

HAZARDS	c[i]	Intensity(max of 5)			Duration (hours)			L of exper. cons[ii]			L exposure to haz[iii]			Magnitude			WF Impact[iv]			Risk Score		
		med	min	max	med	min	max	med	min	max	med	min	max	med	min	max	med	min	max	med	min	max
Barren environments	4	2.6	2.3	3.8	10920.0	10920.0	10920.0	51.3	40.0	75.0	60.0	30.0	70.0	52.5	46.5	58.5	26.9	23.7	30.1	16.1	7.1	21.1
High stocking density	9	3.0	2.0	4.0	10920.0	10920.0	10920.0	32.8	3.0	87.5	60.0	30.0	90.0	60.0	52.0	64.0	19.7	16.7	21.3	9.8	5.0	17.1
Genetic selection for fast growth	3	2.0	1.0	3.0	10920.0	10920.0	10920.0	25.0	15.0	62.5	90.0	70.0	90.0	40.0	34.0	34.0	10.0	8.3	8.7	9.0	5.8	7.8
Feed restriction	6	2.5	2.5	2.5	8190.0	8190.0	8190.0	23.8	22.6	46.4	90.0	70.0	90.0	37.5	34.5	41.3	8.9	0.0	0.0	8.0	0.0	0.0
Low light intensity	4	3.0	2.5	4.0	4368.0	4368.0	4368.0	43.1	23.8	62.5	30.0	10.0	70.0	24.0	22.4	26.0	10.4	9.6	11.3	3.1	1.0	7.9
Poor ventilation	2	3.8	3.5	4.0	5557.5	5557.5	5557.5	20.0	3.0	87.5	40.0	10.0	70.0	38.2	36.1	40.2	7.6	7.1	8.2	3.1	0.7	5.7
Conventional cages	7	3.5	3.0	4.0	10920.0	10920.0	10920.0	38.8	15.0	62.5	10.0	0.0	10.0	70.0	72.0	80.0	27.1	27.6	31.3	2.7	0.0	3.1
Overly dry litter	1	3.0	1.0	4.0	10920.0	10920.0	10920.0	15.0	3.0	15.0	20.0	10.0	50.0	60.0	52.0	68.0	9.0	7.5	10.5	1.8	0.8	5.3
Wet litter	4	3.3	2.5	4.0	10920.0	10920.0	10920.0	13.8	5.5	62.5	20.0	10.0	50.0	65.0	59.0	71.0	8.9	7.8	10.1	1.8	0.8	5.0
Inappropriate diet	5	4.0	2.0	5.0	10920.0	10920.0	10920.0	16.3	1.0	40.0	10.0	0.0	30.0	80.0	72.0	84.0	13.0	11.3	14.2	1.3	0.0	4.2
Beak trimming (in early age)	4	4.0	4.0	4.0	756.0	756.0	756.0	32.5	27.5	75.0	70.0	0.0	90.0	5.5	5.1	6.0	1.8	1.6	2.0	1.3	0.0	1.8
Poor housing design and allocation of resources	4	3.0	1.0	4.0	6825.0	6825.0	6825.0	9.6	3.0	20.0	30.0	10.0	50.0	37.5	20.0	30.0	3.6	1.8	3.0	1.1	0.2	1.5
Reduced mobility	4	4.0	3.0	4.5	5544.0	5544.0	5544.0	17.8	3.0	62.5	10.0	0.0	30.0	40.6	38.6	42.6	7.2	6.7	7.8	0.7	0.0	2.3
High light intensity (incl. Natural lighting)	3	3.0	2.0	4.0	10920.0	10920.0	10920.0	7.5	3.0	7.5	10.0	10.0	50.0	60.0	48.0	72.0	4.5	2.3	4.1	0.5	0.2	2.0
High temperatures and humidity	1	4.0	3.0	5.0	2957.5	2957.5	2957.5	14.0	3.0	25.0	10.0	0.0	10.0	21.7	19.5	23.3	3.0	2.7	3.4	0.3	0.0	0.3

De-toeing	4	4.0	4.0	4.0	168.0	168.0	168.0	27.5	27.5	75.0	70.0	10.0	90.0	1.2	1.1	1.4	0.3	0.3	0.4	0.2	0.0	0.3
De-spurring	3	4.0	4.0	4.0	168.0	168.0	168.0	40.0	40.0	87.5	30.0	10.0	50.0	1.2	1.1	1.3	0.5	0.4	0.5	0.1	0.0	0.3
Not mutilating	1	2.0	2.0	2.0	2730.0	2730.0	2730.0	7.5	3.0	7.5	10.0	10.0	50.0	10.0	8.0	12.0	0.8	0.6	1.0	0.1	0.1	0.5
Comb dubbing	3	4.0	4.0	4.0	168.0	168.0	168.0	40.0	40.0	87.5	10.0	0.0	30.0	1.2	1.1	1.3	0.5	0.4	0.5	0.0	0.0	0.2
Inappropriate light cycle	2	2.8	2.0	4.0	672.0	168.0	672.0	8.3	5.3	11.3	10.0	10.0	30.0	3.4	2.8	4.0	0.3	0.1	0.2	0.0	0.0	0.1
Inappropriate enrichment	2	2.3	2.0	4.5	1462.5	1462.5	1462.5	3.0	1.0	3.0	10.0	10.0	10.0	6.0	5.0	7.1	0.2	0.1	0.2	0.0	0.0	0.0
Lack of appropriate training for stockpersons and animal handlers	7	4.0	2.0	4.0	12.0	12.0	12.0	7.5	3.0	15.0	40.0	10.0	70.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Ad lib feeding	3	4.0	4.0	4.0	84.5	84.5	84.5	32.5	25.0	40.0	0.0	0.0	10.0	0.6	0.6	0.6	0.2	0.2	0.3	0.0	0.0	0.0

Table 2: Top five ranking welfare hazards by magnitude and welfare impact for the production and rearing periods. Note that each period is a generalisation across both sexes, and across the different types of breeder (fast/slow growing). Risk score is not included as there is insufficient information on hazard exposure at different life stages to calculate this.

Group	Magnitude	Welfare Impact
Rearing	Feed restriction	Fast growth
	Fast growth	Feed restriction
	Wet litter	High stocking density
	Barren environments	Low light intensity
	High stocking density	Poor ventilation
Production	Barren environments	Fast growth
	Feed restriction	Barren environments
	High stocking density	Poor ventilation
	Fast growth	Conventional cages
	Wet litter	Wet litter

Table 3: Top five ranking welfare hazards by magnitude and welfare impact for males and females. Note that each sex is considered across its whole lifetime – through both the rearing and production periods, where, as shown in Table 2, the main hazards are different. Risk score is not included as there is insufficient information on hazard exposure in the different sexes to calculate this.

Group	Magnitude	Welfare Impact
Females	Barren environments	Barren environments
	High stocking density	High stocking density
	Fast growth	Fast growth
	Inappropriate diet	Inappropriate diet
	Feed restriction	Feed restriction
Males	Barren environments	Barren environments
	Feed restriction	High stocking density
	High stocking density	Feed restriction
	Fast growth	Fast growth
	Poor housing design	Inappropriate diet

Table 4: Top five ranking welfare hazards by magnitude and welfare impact for fast and slow-growing breeders. Note that each type is considered across its whole lifetime – through both the rearing and production periods, where, as shown in Table 2, the main hazards are different, and for both sexes combined. Risk score is not included as there is insufficient information on hazard exposure in the different sexes to calculate this.

Group	Magnitude	Welfare Impact
Fast growers	Poor housing design	Barren environments
	Barren environments	High stocking density
	High stocking density	Conventional cages
	Conventional cages	Poor housing design
	Fast growth	Fast growth
Slow growers	Barren environments	Barren environments
	Conventional cages	High stocking density
	High stocking density	Conventional cages
	Poor housing design	Poor housing design
	Fast growth	Fast growth

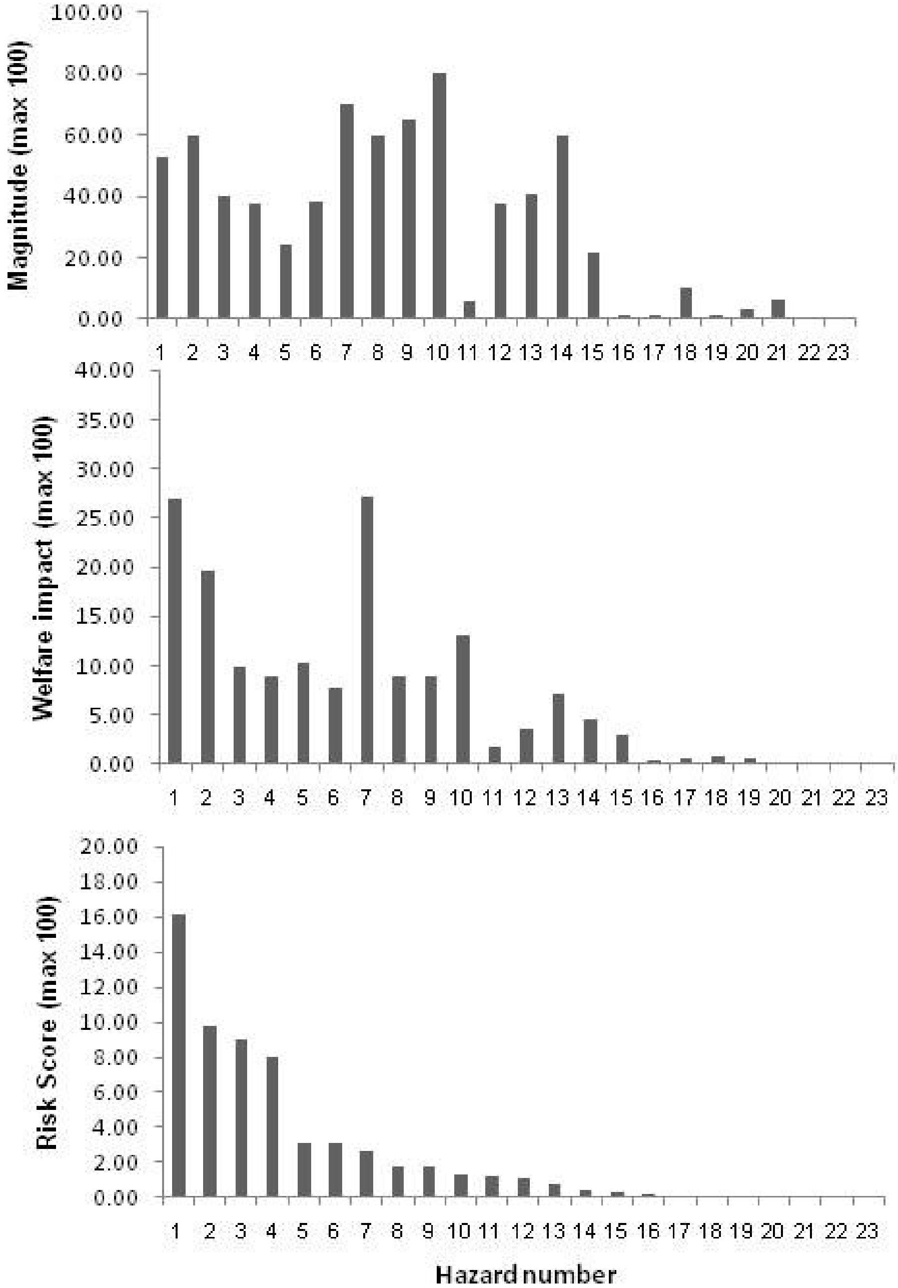

Figure 2: Relative Magnitude, Welfare Impact and Risk Scores for the 23 hazards identified in relation to the environment and housing of broiler breeders, ranked on median risk score (high to low). Note that values are not linear, hence a hazard with a risk score of 20 is not twice the risk of a hazard with score 10.

Hazard code: 1 Barren environments; 2 High stocking density; 3 Genetic selection for fast growth; 4 Feed restriction; 5 Low light intensity; 6 Poor ventilation; 7 Conventional cages; 8 Overly dry litter; 9 Wet litter; 10 Inappropriate diet; 11 Beak trimming (at early age); 12 Poor housing design and allocation of resources; 13 Reduced mobility; 14 High light intensity (incl. Natural lighting); 15 High temperatures and humidity; 16 De-toeing; 17 De-spurring; 18 Not mutilating; 19 Comb dubbing; 20 Inappropriate light cycle; 21 Inappropriate enrichment; 22 Lack of appropriate training for stockpersons and animal handlers; 23 Ad lib feeding.

Uncertainty and variability

Experts did not have uniform uncertainty across the attributes they scored on. Figure 2 shows that experts were less certain of conditional probability of exposure than intensity and duration scores, and there was greater variability in hazard scores for conditional probability of exposure than intensity or duration. Inter-expert variability in duration scores was zero as this particular characteristic was scored in plenary, with experts agreeing on a score then giving independent scores for their own level of uncertainty for that score. The greater uncertainty in conditional probability of exposure than intensity is likely to be a true reflection of knowledge in the field – there is relatively more information available describing adverse effects – their intensity and duration, than quantifying how extensive the problem is. Further to this, it was recognised by the experts that probabilities vary from region to region, country to country and between different types of farming system. Probability estimates consequently had large ranges. Routine data collection across Europe would certainly help to make these estimates more accurate, not least because prevalence information from each country could be included directly in the risk assessment.

One of the assumptions of this risk assessment is that the individual welfare hazards are independent and not interlinked. The ontological analysis conducted as part of Article 36 highlighted that this assumption is not met within the broiler breeder system. The implications of this in terms of the results of the risk assessment are potentially considerable. For highly interlinked factors, the risk score may be slightly over- or (more likely) substantially under-estimated, as the calculated scores in this risk assessment do not take into account second, or higher-order consequences (i.e. consequences of consequences). Figure 4 illustrates this point, using the example of fast growth rate as the hazard. The figure shows that both directly and indirectly, fast growth rate is linked to at least five other hazards characterised in the risk assessment. These include some of the top five ranking hazards – feed restriction and wet litter. The number of consequences a hazard has does not in itself affect the final aggregated scores of magnitude, welfare impact and risk score (as seen in Table 1), as the aggregated scores were calibrated for the number of consequences. However, the characteristics of the consequences (intensity, duration, conditional exposure) did affect the aggregated scores. For highly interlinked factors, therefore, the key information will not be the quantity of links with other factors, but rather the quality of those links – i.e. the characteristics of second and third order consequences, that will determine whether our risk assessment scores are under- or overestimates.

We must also consider that this risk assessment represents the independent opinions of a small group of experts. Each expert scored each hazard once, therefore we have no means of investigating intra-expert reliability of scoring. It is possible that should the same group of experts be asked to complete the same surveys in six months time, they would each give answers that differed to some extent from the answers provided for this report. Similarly, a random sample of different experts may give different values for the risk assessment. This is one of the key criticisms of expert opinion-based risk assessment procedures. In this assessment, we attempted to reduce dominance bias (where the opinion of one dominant individual in the group influences the opinions of others in the group) by asking each expert to score the hazards independently. This highlighted that there was variability in the opinions of the group that was taken into account at the assessment stage. This is widely considered to be best practice for opinion-led risk assessment procedures (Vose, 2000). At the present time, we lack the raw data that would enable us to conduct a fully data-driven, quantitative risk assessment. Given these restrictions, the risk assessment should be interpreted with due caution, bearing in mind that hazards are not independent and that expert opinion is not the equivalent of raw data.

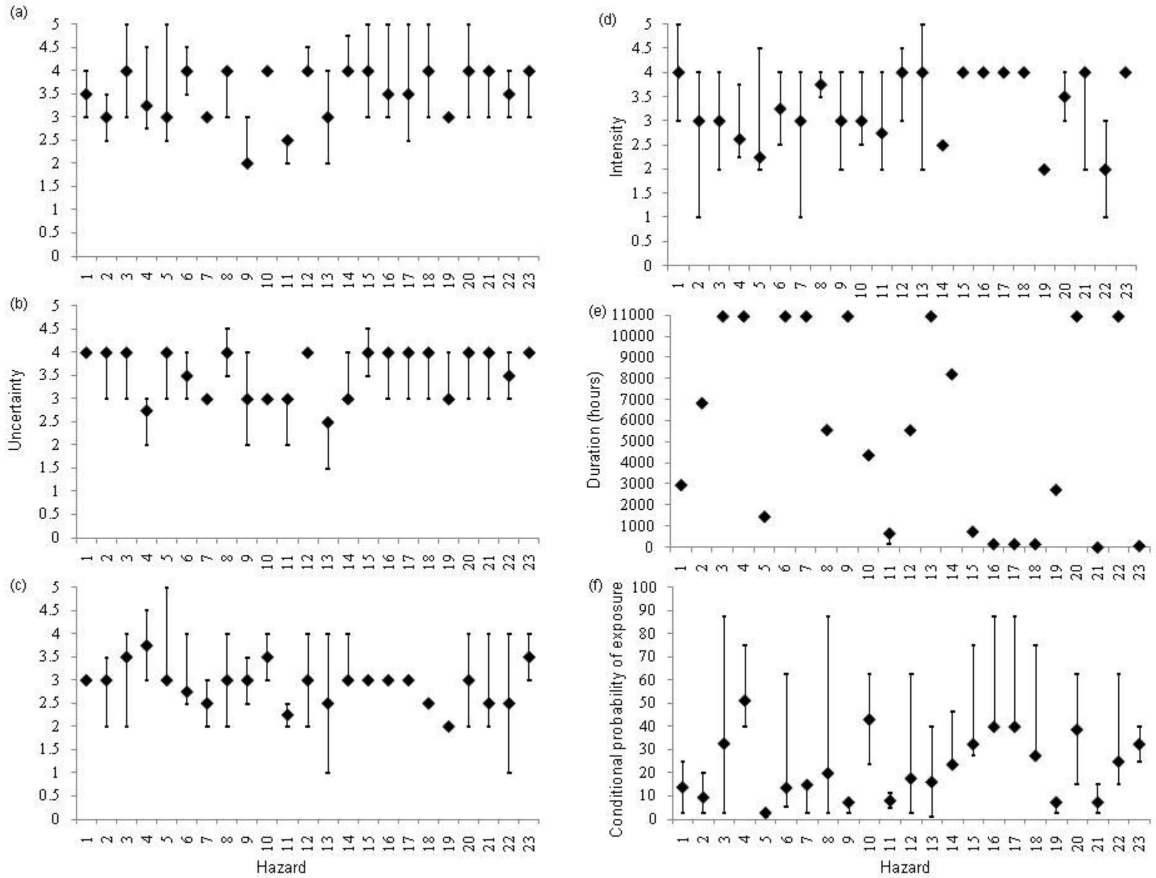

Figure 3: Uncertainty (a-c) and variability (d-f) of hazard intensity (a,d), duration (b,e) and conditional probability of exposure (c,f). Showing that experts were less certain of conditional probability of exposure than intensity and duration, and there was greater variability in hazard scores for conditional probability of exposure than intensity or duration. Please note that duration was assessed in plenary, so variability between members was minimal, though each expert expressed their level of uncertainty in the attributed scores.

Hazard code: 1 High temperatures and humidity; 2 Poor housing design and allocation of resources; 3 High stocking density; 4 Barren environments; 5 Inappropriate enrichment; 6 Wet litter; 7 Overly dry litter; 8 Poor ventilation; 9 High light intensity; 10 Low light intensity; 11 Inappropriate light cycle; 12 Reduced mobility; 13 Inappropriate diet; 14 Feed restriction; 15 Beak trimming (at early age); 16 De-spurring; 17 Comb dubbing; 18 De-toeing; 19 Not mutilating; 20 Conventional cages; 21 Lack of appropriate training for stockpersons and animal handlers; 22 Genetic selection for fast growth; 23 Ad lib feeding.

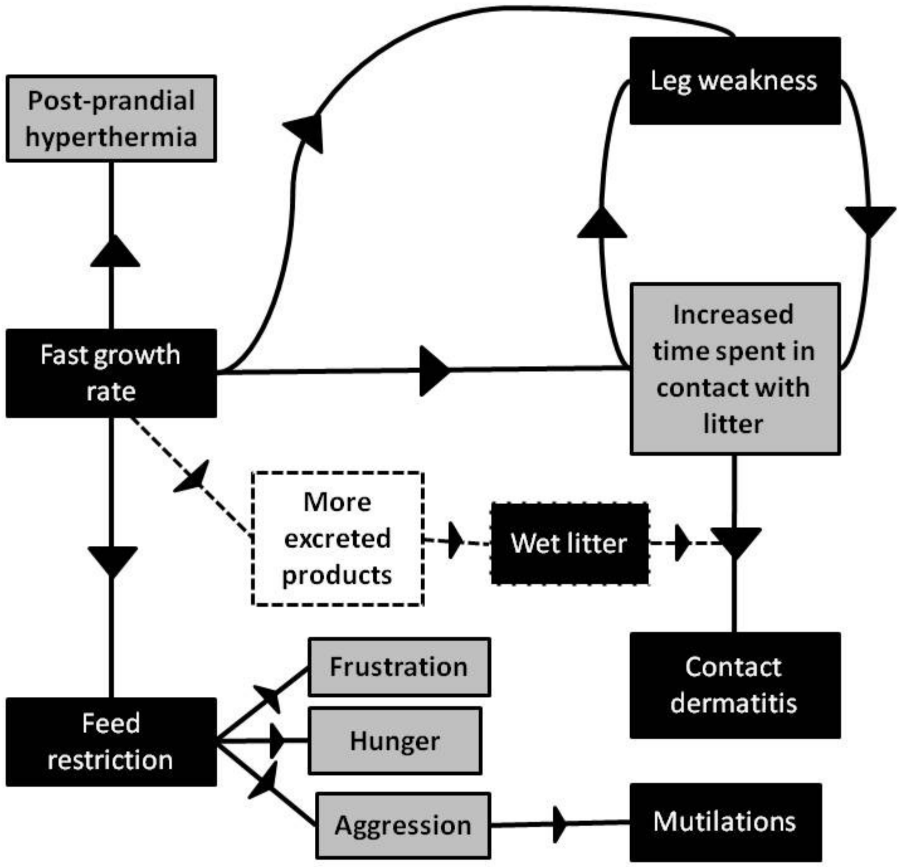

Figure 4: The non-independence of hazards and consequences, using fast growth rate as an example starting hazard. Fast growth rate is shown to be linked both directly and indirectly to other hazards characterised in the risk assessment, which are considered as independent factors. Black boxes are hazards characterised in the risk assessment. Grey boxes are hazard consequences. White boxes explain the relationship between hazards where necessary. Arrows show the direction of causality. Note that this image does not contain all the possible consequences of all the hazards shown.

CONCLUSIONS AND RECOMMENDATIONS

Husbandry and housing systems

Conclusions

Overall, there is a lack of quantitative data on variability of the husbandry and management systems used in Europe. This lack of data could not be fully compensated by the information given by the industry during the technical hearing.

Environmental enrichment is beneficial compared with barren environments, as it increases the chances of meeting the behavioural needs of the birds as well as promoting learning to perch and to use raised nest boxes.

Little is known about how often environmental enrichment is applied and which types are used.

Housing and management of grandparent stock is similar to that of the parent stock, but with a slightly lower stocking density.

Cage housing can be used for grandparent stock, but it is rare.

Recommendations

Quantitative data should be collected on housing and management systems, in particular the allocation of perches and other environment enrichments.

Sufficient perch or platform space should be provided during rearing so that birds learn to navigate in a three-dimensional space and later during the production to provide sufficient space for all those birds that use them.

Cages for breeding birds should meet the same legal requirements, for litter, nest box and perches, as for laying hens.

Feed restriction

Conclusions

Non-restricted feeding of standard birds will cause welfare problems, mostly correlated to the high body weight. In experimental studies a mortality of 40% (up to 40 or 49 weeks of age) was found compared to 6 % for breeders under restricted feeding.

Feed restrictions introduced to reduce the welfare problems associated with unrestricted feeding are causing other types of problems associated with hunger such as competition around feeding time in males and females and aggression which can lead to injury.

The degree of restriction has been increasing over recent decades as birds have been selected for ever higher growth rates.

There is a genetic component as the degree of restriction necessary e.g. for mini-breeders is lower than that for standard breeding birds.

The welfare outcomes of alternative feeding strategies, like diet dilution, appetite suppressants and "skip a day" practice are not fully known.

Recommendations

Birds that require less feed restriction should be selected as future breeders. This may involve reduced selection pressure on high growth rates.

The trend in the degree of feed restriction required to maintain broiler breeder bodyweight targets should be monitored.

A feather and injury scoring method should be developed to measure the level and extend of damage caused by aggressive behaviour.

Management of the distribution of the feed should minimize competition between birds and reduce injuries.

The possible impact on welfare of alternative feeding strategies should be evaluated.

Mating aggression

Conclusions

Aggression by males during mating can be a welfare problem, but the extent of injury and its prevalence are unknown.

There may well be a genetic component that could be used to reduce mating aggression.

It is important that males do not reach sexual maturity earlier than females when they are kept together.

Recommendations

Males should not be introduced until the females are sexually mature.

Mutilations

Conclusions

Mutilations like de- spurring, beak trimming and toe clipping have been introduced to avoid welfare problems like skin damages.

The extent to which each mutilation is carried out in MS is not known. Sometimes mutilations have become routine for traditional reasons and may no longer be required.

The consequences for welfare, the effectiveness of the mutilations, and the methods used have not been quantified.

Recommendations

Quantitative data on the prevalence and effectiveness of the different types of mutilations such as beak trimming, de-toeing and de-spurring and the methods used should be collected.

No mutilation with effect on welfare as severe as those resulting from cutting off toes or dubbing should be carried out unless justified by evidence for substantial and unavoidable level of poor welfare in other birds.

Mutilations should be carried out by trained personnel using the least painful methods.

Slaughter and culling

Conclusions

If slaughter methods are not adapted to the higher weights of birds, welfare problems are likely to occur (e.g. crate height too low, stocking density too dense). In addition, shackling may injure the birds when stunned electrically and the voltage and/or current may be too low.

Recommendations

Transport crates (size, and height) should be appropriate to the size of birds, and slaughterhouse facilities should have shackles and stunning procedures equipped for adult broiler breeder birds.

Training for those who cull broiler breeders should be put in place.

Disease and biosecurity

Conclusions

There are no systematically collected data on the prevalence of contact dermatitis conditions such as hock burn, and footpad dermatitis, in broiler breeders.

There are no systematically collected data available on leg disorders in broiler breeders.

There is a lack of surveillance data for many infectious diseases in broiler breeders.

Recommendations

A standardised gait scoring system should be developed for broiler breeders so that it can be used to assess leg disorders and associated pain.

The results of monitoring infectious disease in broiler breeders should be recorded.

There is generally a lack of surveillance in broiler breeder disease and there is a need to have up-to-date information on the incidence and prevalence of contact dermatitis conditions, leg weakness as well as other diseases.

Welfare Indicators

Recommendations

The following recommendations relate specifically to potential animal-based welfare outcome indicators for use during monitoring or inspection of grand-parent and parent stocks, as well as for monitoring trends over time:

The systematic recording of mortality and culling rates (and/or a new indicator combining these) as well as culling methods, should be instigated and evaluated as potentially useful indicators of welfare and to monitor trends. A welfare outcome indicator should then be developed that expresses culling and mortality as a proportion of all dead birds.

The prevalence of footpad lesions and hock burns in broiler breeders should be determined based upon the methods established for broilers. If the prevalence is high, then systematic recording should be instigated to monitor trends.

To modify a standardised gait scoring system developed for broilers so that it can be used to determine the prevalence of leg weakness in breeding birds. If the prevalence of the worst gait scores is high, then systematic recording should be instigated to monitor trends.

The prevalence of feather damage, skin damage and other injuries (including pecking damage to the comb) should be determined using the methods established for broilers and laying hens. If the prevalence is high, then systematic recording should be instigated to monitor trends in the levels of aggression and abnormal behaviour.

Data on welfare measures, such as ‘dead on arrival’ should be collected at the slaughterhouse.

The potential of using the incidence of spot pecking and over drinking as welfare outcome indicators related to hunger should be evaluated.

The potential of using the proportion of birds perching at night time as a welfare outcome indicator of appropriate provision of perches should be evaluated.

Recommendations for future research

Research to evaluate the potential acute and chronic pain associated with de-toeing and de-spurring as well as the consequence for the welfare of other birds of not performing these mutilations should be obtained.

Further research on the relationship between hunger and feed restriction is needed, to limit the negative welfare effects, particularly in broiler breeder males.

Future studies should focus on the behaviour of restricted fed birds in commercial flocks.

Future research should focus on management strategies to alleviate the hunger associated with feed restriction during rearing, e.g. to determine an appropriate level of restriction to the point where birds are not hungry but do not suffer from health problems linked with unrestricted feeding

Future research should focus on reducing injuries to females during mating and on the genetic components that could be used to reduce aggression during mating.

As cover panels seem to prevent excessive mating in broiler breeders they should be tested at European production farms.

There is a need for more research specifically on broiler breeders and the practical application of environment enrichment in particular comfortable and secure resting facilities.

Welfare outcome indicators should be developed for assessing welfare at the abattoir such as: temperature of birds, feather cover and skin injuries, dead on arrival.

Future research should focus on the impact of spiking on animal welfare.

The impact of the reduction of growth rate on welfare, health (and performances) of breeders (hunger, frustration, metabolic disorders…) should be investigated.

Risk assessment

Conclusion

The top five hazards according to risk scores of carried out risk assessments are barren environment, high stocking density, fast growth rate, feed restriction and low light intensity. These five hazards are ranked highly either because the adverse effects are intense and/or prolonged, and/or the probability of the birds being exposed to these five hazards is high and the probability of experiencing adverse effects when exposed to these hazards is high.

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APPENDICES

A. THE POULTRY BREEDING SECTOR

Broiler breeding consists of selecting animals with a blend of various desired characteristics, mating the selected animals, taking the wide range of offspring, rearing and crossing them with others within the flock produced in various combinations (multiplying). The results of breeding are cumulative and so add up generation after generation, and are widely disseminated. For example, a group of 1 male and 10 females in one of the male great grandparent populations can contribute 25% of the genetic material of approximately 87.5 million broilers in 4 - 5 years.

Over time the selection of broilers has evolved from selection for 'simple' and 'single' criteria (e.g. growth, body conformation) to selection programmes with multiple traits which balance between meat production, growth rate, reproduction and disease resistance. During the hearing with three breeding companies it was stated that they included several aspects of leg disorders in their breeding programme. According to these breeding companies, other welfare related critical conditions known to be heritable have been included in selection programmes as selection traits (ref. technical hearing).

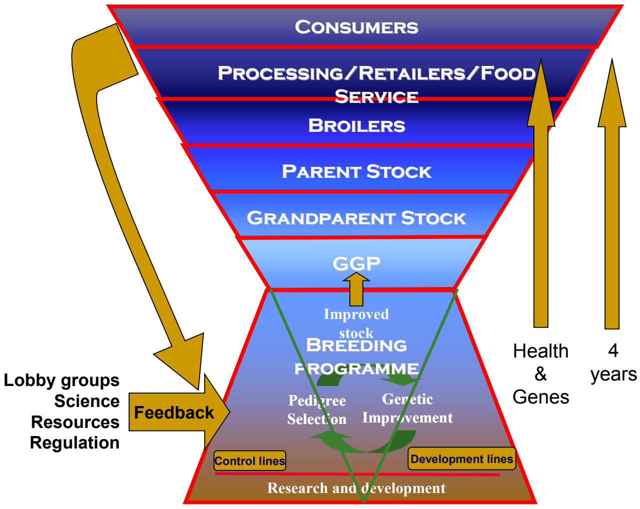

Figure: Industry structures for broiler breeding programmes (Laughlin, 2007). The figure illustrates the role of the breeding companies in providing the stock that eventually provides consumers with poultry meat.

The reproductive rate of birds has enabled just a few companies to provide the world with breeding stocks. These breeding companies have evolved into multiple brand/breed companies providing lines for the various types of broilers needed worldwide. The final choice from the available phenotypes is made by the producer/customer within each market and region (e.g. different amounts of breast versus leg meat, slow growing, coloured skin, coloured feather, tolerance to different environments). The breeding companies provide management guides for the farmers for the different types of breeds in order to optimize performance.

There is a generation interval of 4 years from pedigree stock to broiler production stock (Fig. 5).

Approximately 60-70 % of broiler breeding stock has developed within European companies and the demand for their products from outside Europe is increasing (Van Horne and Achterbosch, 2008). There is a global production shift to developing economies (e.g. China, Brazil, India). These emerging production regions have brought needs for specific phenotypes and specific tuning of existing phenotypes for the different markets.

B. Risk assessment tables: welfare magnitude

Table 5: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores are for all broiler breeders, across production stages, genders and growth rates.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	100.00	92.00	100.00
Conventional cages	Reduced behavioural repertoire	80.00	80.00	80.00
Conventional cages	Movement restriction	80.00	80.00	80.00
Low light intensity	Reduced perception ability of the bird	80.00	78.00	82.00
Poor housing design and allocation of resources	Reduced behavioural repertoire	80.00	76.00	84.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Reduced mobility	Reduced ability to perform normal behavioural repertoire	80.00	76.00	84.00
Wet litter	Atmospheric ammonia irritating the respiratory tract	80.00	76.00	84.00
Inappropriate diet	Outbreak of feather pecking	80.00	76.00	84.00
Beak trimming (in early age)	Deformed beak leading to feeding difficulties	80.00	74.00	86.00
Inappropriate diet	Hunger	80.00	72.00	88.00
Inappropriate diet	Thirst	80.00	71.99	88.00
Conventional cages	Frustration	70.00	68.00	72.00
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucous membranes), dust, atmospheric ammonia irritating the respiratory tract	70.00	66.00	74.00
Reduced mobility	Increased time spent in contact with litter	70.00	66.00	74.00
Conventional cages	Boredom	70.00	66.00	74.00
High stocking density	Movement restriction	60.00	58.00	62.00
Wet litter	Pain from footpad dermatitis	60.00	56.00	64.00
High stocking density	Reduced behavioural repertoire	60.00	54.00	66.00
High stocking density	Disturbed rest periods	60.00	52.00	68.00
Overly dry litter	Dust irritating the respiratory tract including increased bacterial load	60.00	52.00	68.00
High light intensity (incl. Natural lighting)	Feather pecking	60.00	52.00	68.00
Inappropriate diet	Diet-related bone problems	60.00	52.00	68.00

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
High light intensity (incl. Natural lighting)	Aggression	60.00	48.00	72.00
Wet litter	Pain from hock burns	50.00	46.00	54.00
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	50.00	42.00	58.00
High stocking density	Increased transmission of infectious diseases	40.00	36.00	44.00
Feed restriction	Hunger	40.00	36.00	44.00
Genetic selection for fast growth	Leg weakness (males)	40.00	34.00	46.00
Conventional cages	Abnormal behaviour (feather, spot pecking…)	30.00	27.00	33.00
Barren environments	Frustration	20.00	16.00	24.00
Barren environments	Boredom	20.00	12.00	28.00
High stocking density	Injury through contact with other birds	15.00	13.00	17.00
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	15.00	12.00	18.00
High stocking density	Injury through contact with physical structures	12.50	10.50	14.50
Inappropriate enrichment	Injury	12.50	10.50	14.50
Poor housing design and allocation of resources	Injury through contact with other birds	10.00	8.00	12.00
Poor housing design and allocation of resources	Injury through contact with physical structures	10.00	8.00	12.00
Feed restriction	Injury (scratches, pecking)	10.00	8.00	12.00
Conventional cages	Injury through contact with other birds	10.00	7.50	12.50
Conventional cages	Injury through contact with physical structures	10.00	7.50	12.50
Wet litter	Atmospheric ammonia irritating the eyes	2.50	2.21	2.79
Beak trimming (in early age)	Pain at time of beak trimming	1.54	1.51	1.54
De-toeing	Pain at time of de-toeing	1.54	1.48	1.54
De-spurring	Pain at time of de-spurring	1.54	1.41	1.54
Comb dubbing	Pain at time of comb dubbing	1.54	1.41	1.54
Poor ventilation	Hyperthermia (temperature and relative humidity)	1.43	1.35	1.51
Reduced mobility	Reduced ability to reach feed/water when motivated	1.23	1.17	1.29
Reduced mobility	Birds experiencing pain	1.23	1.17	1.29
Ad lib feeding	Inability to walk / leg weakness	1.23	1.17	1.30
Lack of appropriate training for stockpersons and animal handlers	Culling too late	1.23	1.14	1.32

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Inappropriate light cycle	Delayed or early sexual maturity	1.23	0.86	1.60
High stocking density	Heat stress	1.19	1.09	1.29
Inappropriate enrichment	Birds getting trapped in enrichment objects	0.71	0.57	0.86
Lack of appropriate training for stockpersons and animal handlers	Handling-associated stress	0.36	0.32	0.40
Lack of appropriate training for stockpersons and animal handlers	Injury during catching process	0.09	0.08	0.09
Lack of appropriate training for stockpersons and animal handlers	Insufficient stunning	0.01	0.01	0.01
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.01	0.01	0.01
Lack of appropriate training for stockpersons and animal handlers	Inefficient culling method	0.01	0.01	0.01
Beak trimming (in early age)	Handling-related stress	0.01	0.01	0.01
De-spurring	Handling-related stress	0.01	0.01	0.01
Comb dubbing	Handling-related stress	0.01	0.01	0.01
De-toeing	Handling-related stress	0.01	0.01	0.01
Lack of appropriate training for stockpersons and animal handlers	Inappropriate shackling	0.01	0.01	0.01

Table 6: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to female broiler breeders.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	100.00	94.00	100.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Inappropriate diet	Hunger	80.00	72.00	88.00
Poor housing design and allocation of resources	Frustration	60.00	60.00	60.00
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	60.00	52.00	68.00
Feed restriction	Frustration	40.00	36.00	44.00
Conventional cages	Abnormal behaviour (feather, spot pecking…)	30.00	27.00	33.00
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	12.50	10.00	15.00
Poor housing design and allocation of resources	Injury through contact with other birds	10.00	8.00	12.00
Inappropriate light cycle	Delayed or early sexual maturity	3.08	2.83	3.33
Ad lib feeding	Inability to walk / leg weakness	1.23	1.17	1.30

Table 7: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to male broiler breeders.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	90.00	84.00	96.00
Poor housing design and allocation of resources	Frustration	80.00	80.00	80.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Feed restriction	Frustration	80.00	76.00	84.00
Inappropriate diet	Hunger	80.00	74.00	86.00
High stocking density	Increased transmission of infectious diseases	50.00	46.00	54.00
Genetic selection for fast growth	Leg weakness (males)	50.00	46.00	54.00
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	50.00	42.00	58.00
Conventional cages	Abnormal behaviour (feather, spot pecking…)	30.00	27.00	33.00
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	15.00	12.50	17.50
Poor housing design and allocation of resources	Injury through contact with other birds	10.00	8.00	12.00
Inappropriate light cycle	Delayed or early sexual maturity	2.46	2.21	2.71
Ad lib feeding	Inability to walk / leg weakness	1.38	1.32	1.45

Table 8: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to the production stage of broiler breeders.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
High stocking density	Reduced air quality	80.00	76.00	84.00
Barren environments	Reduced behavioural repertoire	60.00	56.00	64.00
Wet litter	Pain from hock burns	60.00	56.00	64.00
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucous membranes), dust, atmospheric ammonia irritating the respiratory tract	60.00	56.00	64.00
High stocking density	Increased transmission of infectious diseases	60.00	56.00	64.00
Feed restriction	Frustration	40.00	40.00	40.00
Feed restriction	Increased competition, aggression	40.00	38.00	42.00
Feed restriction	Hunger	40.00	38.00	42.00
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	40.00	36.00	44.00

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Abnormal behaviour (feather, spot pecking…)	40.00	32.00	48.00
Conventional cages	Abnormal behaviour (feather, spot pecking…)	30.00	27.00	33.00
High stocking density	More males in a reduced area (male-male interaction)	20.00	18.40	21.60
Barren environments	Boredom	20.00	12.00	28.00
High stocking density	Injury through contact with physical structures	15.00	13.00	17.00
Feed restriction	Abnormal behaviour (over-drinking, spot pecking)	10.00	8.00	12.00
Not mutilating	Injury by others	10.00	8.00	12.00
Poor housing design and allocation of resources	Injury through contact with other birds	10.00	8.00	12.00
Inappropriate enrichment	Injury	10.00	8.00	12.00
Inappropriate light cycle	Delayed or early sexual maturity	3.08	2.83	3.33
High temperatures and humidity	Hyperthermia/heat stress (post-prandial)	2.92	2.66	3.17
Wet litter	Atmospheric ammonia irritating the eyes	2.14	1.93	2.36
Poor ventilation	Hyperthermia (temperature and relative humidity)	1.43	1.35	1.51
Reduced mobility	Reduced ability to reach feed/water when motivated	1.23	1.17	1.29
Reduced mobility	Birds experiencing pain	1.23	1.17	1.29
Lack of appropriate training for stockpersons and animal handlers	Injury during (de)crating process	0.01	0.00	0.01
Feed restriction	Hyperthermia (post-prandial)	0.00	0.00	0.17

Table 9: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to the rearing stage of broiler breeders.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Feed restriction	Increased competition, aggression	100.00	98.00	100.00
Feed restriction	Hunger	100.00	98.00	100.00
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	100.00	96.00	100.00
Feed restriction	Frustration	100.00	96.00	100.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Barren environments	Reduced behavioural repertoire	80.00	76.00	84.00
Wet litter	Pain from footpad dermatitis	80.00	76.00	84.00
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucous membranes), dust, atmospheric ammonia irritating the respiratory tract	80.00	76.00	84.00

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Wet litter	Pain from hock burns	60.00	56.00	64.00
Low light intensity	Reduced perception ability of the bird	60.00	56.00	64.00
Feed restriction	Abnormal behaviour (over-drinking, spot pecking)	50.00	47.99	50.01
Barren environments	Abnormal behaviour (feather, spot pecking…)	50.00	42.00	58.00
High temperatures and humidity	Hyperthermia/heat stress (post-prandial)	40.00	36.99	43.01
Conventional cages	Abnormal behaviour (feather, spot pecking…)	30.00	27.00	33.00
Low light intensity	Reduced behavioural repertoire	24.00	22.40	25.60
Low light intensity	Increased time spent in contact with litter	24.00	21.60	26.40
Low light intensity	Reduced activity	20.00	18.40	21.60
Barren environments	Boredom	20.00	12.00	28.00
Inappropriate enrichment	Injury	15.00	13.00	17.00
Not mutilating	Injury by others	10.00	8.00	12.00
Poor housing design and allocation of resources	Injury through contact with other birds	10.00	8.00	12.00
High stocking density	Injury through contact with physical structures	10.00	8.00	12.00
Inappropriate light cycle	Delayed or early sexual maturity	2.46	2.21	2.71
Wet litter	Atmospheric ammonia irritating the eyes	2.14	1.93	2.36
Feed restriction	Hyperthermia (post-prandial)	1.67	1.50	1.84
Reduced mobility	Reduced ability to reach feed/water when motivated	1.23	1.17	1.29
Reduced mobility	Birds experiencing pain	1.23	1.17	1.29
Lack of appropriate training for stockpersons and animal handlers	Injury during (de)crating process	0.92	0.86	0.99
Poor ventilation	Hyperthermia (temperature and relative humidity)	0.53	0.50	0.56

Table 10: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to the fast-growing breeds of broiler breeder.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Poor housing design and allocation of resources	Frustration	100.00	90.00	100.00
Conventional cages	Reduced behavioural repertoire	80.00	80.00	80.00
Conventional cages	Movement restriction	80.00	80.00	80.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Barren environments	Reduced behavioural repertoire	80.00	74.00	86.00
Conventional cages	Frustration	70.00	68.00	72.00
Conventional cages	Boredom	70.00	66.00	74.00
High stocking density	Disturbed rest periods	60.00	56.00	64.00
Genetic selection for fast growth	Leg weakness (males)	50.00	42.00	58.00
Conventional cages	Abnormal behaviour (feather pecking, spot pecking…)	30.00	27.00	33.00
Conventional cages	Injury through contact with other birds	10.00	7.50	12.50
Conventional cages	Injury through contact with physical structures	10.00	7.50	12.50
Feed restriction	Hyperthermia (post-prandial)	1.67	1.66	1.67
Ad lib feeding	Inability to walk / leg weakness	1.38	1.38	1.39
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.01	0.01	0.01

Table 11: Magnitude of consequences of environment and housing in broiler breeders, ranked from highest relative score to lowest. These scores relate specifically to the slow-growing breeds of broiler breeder.

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	100.00	94.00	100.00
Conventional cages	Reduced behavioural repertoire	80.00	80.00	80.00
Conventional cages	Movement restriction	80.00	80.00	80.00
High stocking density	Reduced air quality	80.00	76.00	84.00
Conventional cages	Frustration	80.00	76.00	84.00
Conventional cages	Boredom	80.00	72.00	88.00
Poor housing design and allocation of resources	Frustration	80.00	70.00	90.00
Genetic selection for fast growth	Leg weakness (males)	40.00	34.00	46.00
Conventional cages	Abnormal behaviour (feather pecking, spot pecking…)	30.00	27.00	33.00
Conventional cages	Injury through contact with other birds	10.00	7.50	12.50
Conventional cages	Injury through contact with physical structures	10.00	7.50	12.50

		MAGNITUDE		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Ad lib feeding	Inability to walk / leg weakness	1.23	1.23	1.23
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.01	0.01	0.01

Table 12: Welfare hazards and consequences that could not be quantified, as there is too little information available on these consequences.

HAZARDS	**Consequences**
Wet litter	Atmospheric ammonia irritating the respiratory tract
Wet litter	Atmospheric ammonia irritating the respiratory tract
Inappropriate light cycle	Egg peritonitis/ salpingitis
Inappropriate diet	Diet-related skin problems
Beak trimming (in early age)	On-going pain (state method in comments box)
De-spurring	On-going pain
Comb dubbing	On-going pain
De-toeing	On-going pain
De-toeing	Inability to perch
Genetic selection for fast growth	Metabolic disorders
Ad lib feeding	More spiking

C. Risk assessment tables: welfare impact

Table 13: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all broiler breeders.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	87.50	80.32	87.70
Conventional cages	Reduced behavioural repertoire	60.00	59.84	60.16
Conventional cages	Movement restriction	60.00	59.84	60.16
Low light intensity	Reduced perception ability of the bird	50.00	48.51	51.50
High stocking density	Reduced air quality	50.00	47.27	52.75
High stocking density	Disturbed rest periods	38.25	32.99	43.55
High stocking density	Movement restriction	37.50	36.13	38.87
High stocking density	Reduced behavioural repertoire	37.50	33.59	41.45
Conventional cages	Frustration	35.88	34.58	37.19
Wet litter	Atmospheric ammonia irritating the respiratory tract	31.00	29.14	32.89
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	28.13	23.50	32.80
Conventional cages	Boredom	27.13	25.31	28.97
Poor housing design and allocation of resources	Reduced behavioural repertoire	20.00	18.85	21.17
Beak trimming (in early age)	Deformed beak leading to feeding difficulties	20.00	18.20	21.84
Inappropriate diet	Outbreak of feather pecking	19.00	17.59	20.45
Inappropriate diet	Hunger	19.00	16.74	21.34
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucous membranes), dust, atmospheric ammonia irritating the respiratory tract	17.50	16.30	18.72
Reduced mobility	Reduced ability to perform normal behavioural repertoire	17.20	16.04	18.40
Inappropriate diet	Thirst	13.00	11.27	14.83
Barren environments	Frustration	10.25	8.17	12.35
Barren environments	Boredom	10.25	6.11	14.43
Overly dry litter	Dust irritating the respiratory tract including increased bacterial load	9.00	7.54	10.54
Reduced mobility	Increased time spent in contact with litter	6.30	5.68	6.96
Conventional cages	Abnormal behaviour (feather, spot pecking…)	4.50	4.00	5.02
Wet litter	Pain from footpad dermatitis	4.50	3.92	5.12
High light intensity (incl. Natural lighting)	Feather pecking	4.50	3.69	5.37
Genetic selection for fast growth	Leg weakness (males)	4.50	3.65	5.41
Wet litter	Pain from hock burns	3.75	3.22	4.32

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Inappropriate diet	Diet-related bone problems	2.55	1.95	3.23
High stocking density	Injury through contact with other birds	2.25	1.91	2.60
High light intensity (incl. Natural lighting)	Aggression	1.80	1.25	2.45
High stocking density	Increased transmission of infectious diseases	1.20	0.94	1.50
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	1.13	0.00	0.00
High stocking density	Injury through contact with physical structures	0.94	0.75	1.15
Feed restriction	Injury (scratches, pecking)	0.75	0.57	0.95
Conventional cages	Injury through contact with other birds	0.75	0.53	0.99
Conventional cages	Injury through contact with physical structures	0.75	0.53	0.99
Ad lib feeding	Inability to walk / leg weakness	0.63	0.59	0.67
Beak trimming (in early age)	Pain at time of beak trimming	0.62	0.60	0.62
De-toeing	Pain at time of de-toeing	0.62	0.58	0.62
De-spurring	Pain at time of de-spurring	0.62	0.56	0.62
Comb dubbing	Pain at time of comb dubbing	0.62	0.56	0.62
Poor housing design and allocation of resources	Injury through contact with other birds	0.53	0.39	0.68
Wet litter	Atmospheric ammonia irritating the eyes	0.50	0.43	0.57
Reduced mobility	Reduced ability to reach feed/water when motivated	0.40	0.38	0.43
Inappropriate enrichment	Injury	0.38	0.27	0.49
Poor housing design and allocation of resources	Injury through contact with physical structures	0.30	0.21	0.41
Poor ventilation	Hyperthermia (temperature and relative humidity)	0.21	0.20	0.23
Reduced mobility	Birds experiencing pain	0.17	0.16	0.19
Inappropriate light cycle	Delayed or early sexual maturity	0.11	0.07	0.15
High stocking density	Heat stress	0.09	0.08	0.10
Lack of appropriate training for stockpersons and animal handlers	Culling too late	0.04	0.03	0.05
Lack of appropriate training for stockpersons and animal handlers	Handling-associated stress	0.03	0.02	0.03
Inappropriate enrichment	Birds getting trapped in enrichment objects	0.02	0.01	0.03
Lack of appropriate training for stockpersons and animal handlers	Injury during catching process	0.01	0.01	0.02
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.00	0.00	0.00

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Beak trimming (in early age)	Handling-related stress	0.00	0.00	0.00
De-spurring	Handling-related stress	0.00	0.00	0.00
Comb dubbing	Handling-related stress	0.00	0.00	0.00
De-toeing	Handling-related stress	0.00	0.00	0.00
Lack of appropriate training for stockpersons and animal handlers	Inappropriate shackling	0.00	0.00	0.00
Lack of appropriate training for stockpersons and animal handlers	Inefficient culling method	0.00	0.00	0.00
Lack of appropriate training for stockpersons and animal handlers	Insufficient stunning	0.00	0.00	0.00

Table 14: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all female broiler breeders. All quantities are to 2 decimal points.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	87.50	82.06	87.70
High stocking density	Reduced air quality	50.00	47.27	52.75
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	33.75	29.09	38.45
Inappropriate diet	Hunger	19.00	16.74	21.34
Poor housing design and allocation of resources	Frustration	8.40	8.40	8.40
Conventional cages	Abnormal behaviour (feather, spot pecking…)	6.30	5.62	7.00
Feed restriction	Frustration	3.00	3.00	3.00
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	1.41	1.08	1.75
Poor housing design and allocation of resources	Injury through contact with other birds	0.75	0.57	0.95
Ad lib feeding	Inability to walk / leg weakness	0.49	0.46	0.52
Inappropriate light cycle	Delayed or early sexual maturity	0.28	0.24	0.32

Table 15: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all male broiler breeders. All quantities are to 2 decimal points.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	78.75	73.33	84.19
High stocking density	Reduced air quality	50.00	47.27	52.75
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	28.13	23.50	32.80
Feed restriction	Frustration	20.00	20.00	20.00
Inappropriate diet	Hunger	19.00	17.20	20.86
Poor housing design and allocation of resources	Frustration	11.20	11.20	11.20
Conventional cages	Abnormal behaviour (feather, spot pecking…)	6.00	5.35	6.67
Genetic selection for fast growth	Leg weakness (males)	5.63	4.94	6.35
High light intensity (incl. Natural lighting)	Scratches on the back of the bird	2.44	1.98	2.91
High stocking density	Increased transmission of infectious diseases	1.50	1.20	1.84
Ad lib feeding	Inability to walk / leg weakness	0.87	0.82	0.91
Poor housing design and allocation of resources	Injury through contact with other birds	0.30	0.21	0.41
Inappropriate light cycle	Delayed or early sexual maturity	0.22	0.19	0.26

Table 16: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all production stage broiler breeders. All quantities are to 2 decimal points.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	52.50	48.89	56.13
High stocking density	Reduced air quality	50.00	47.27	52.75
Wet litter	Atmospheric ammonia irritating the respiratory tract	32.00	30.17	33.85
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	17.50	15.61	19.43
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucus membranes), dust, atmospheric ammonia irritating the respiratory tract	15.00	13.83	16.19
Barren environments	Boredom	8.00	4.78	11.26
High stocking density	More males in a reduced area (male-male interaction)	6.55	5.92	7.20
Barren environments	Abnormal behaviour (feather, spot pecking…)	6.00	4.67	7.39

HAZARDS	Consequences	WELFARE IMPACT MEDIAN	MIN	MAX
Conventional cages	Abnormal behaviour (feather, spot pecking…)	5.70	5.08	6.34
Wet litter	Pain from hock burns	4.50	3.92	5.12
Feed restriction	Hunger	3.00	2.77	3.23
Feed restriction	Increased competition, aggression	3.00	2.70	3.32
High stocking density	Increased transmission of infectious diseases	1.80	1.46	2.18
High stocking density	Injury through contact with physical structures	1.13	0.92	1.34
Not mutilating	Injury by others	0.75	0.55	0.97
Poor housing design and allocation of resources	Injury through contact with other birds	0.53	0.39	0.68
Inappropriate light cycle	Delayed or early sexual maturity	0.46	0.41	0.51
High temperatures and humidity	Hyperthermia/heat stress (post-prandial)	0.41	0.36	0.46
Wet litter	Atmospheric ammonia irritating the eyes	0.32	0.28	0.36
Feed restriction	Abnormal behaviour (overdrinking, spotpecking)	0.30	0.21	0.41
Inappropriate enrichment	Injury	0.30	0.21	0.41
Poor ventilation	Hyperthermia (temperature and relative humidity)	0.21	0.20	0.23
Reduced mobility	Reduced ability to reach feed/water when motivated	0.04	0.03	0.04
Reduced mobility	Birds experiencing pain	0.04	0.03	0.05
Lack of appropriate training for stockpersons and animal handlers	Injury during (de)crating process	0.00	0.00	0.00

Table 17: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all rearing stage broiler breeders. All quantities are to 2 decimal points.

HAZARDS	Consequences	WELFARE IMPACT MEDIAN	MIN	MAX
Barren environments	Reduced behavioural repertoire	70.00	66.35	73.67
Genetic selection for fast growth	Suffering from necessary feed restriction to prevent obesity	63.75	60.81	64.15
High stocking density	Reduced air quality	50.00	47.27	52.75
Feed restriction	Hunger	40.00	38.90	40.30
Feed restriction	Increased competition, aggression	40.00	38.81	40.40
Feed restriction	Frustration	40.00	37.82	40.60
Low light intensity	Reduced perception ability of the bird	37.50	34.72	40.32
Feed restriction	Abnormal behaviour (overdrinking, spotpecking)	20.00	18.96	20.25

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Poor ventilation	Increased exposure to endotoxins (inflammatory response in mucus membranes), dust, atmospheric ammonia irritating the respiratory tract	20.00	18.77	21.25
Low light intensity	Reduced behavioural repertoire	12.30	11.37	13.25
Wet litter	Atmospheric ammonia irritating the respiratory tract	12.00	11.17	12.85
Low light intensity	Increased time spent in contact with litter	8.40	7.45	9.37
Barren environments	Boredom	8.00	4.78	11.26
Barren environments	Abnormal behaviour (feather, spot pecking…)	7.50	6.13	8.93
Low light intensity	Reduced activity	7.00	6.35	7.67
Wet litter	Pain from footpad dermatitis	6.00	5.32	6.72
Conventional cages	Abnormal behaviour (feather, spot pecking…)	5.40	4.81	6.01
Wet litter	Pain from hock burns	4.50	3.92	5.12
High temperatures and humidity	Hyperthermia/heat stress (post-prandial)	3.00	2.63	3.40
High stocking density	Injury through contact with physical structures	0.75	0.57	0.95
Not mutilating	Injury by others	0.75	0.55	0.97
Inappropriate enrichment	Injury	0.45	0.34	0.58
Wet litter	Atmospheric ammonia irritating the eyes	0.43	0.38	0.48
Poor housing design and allocation of resources	Injury through contact with other birds	0.30	0.21	0.41
Inappropriate light cycle	Delayed or early sexual maturity	0.22	0.19	0.26
Lack of appropriate training for stockpersons and animal handlers	Injury during (de)crating process	0.13	0.12	0.14
Feed restriction	Hyperthermia (post-prandial)	0.13	0.11	0.14
Poor ventilation	Hyperthermia (temperature and relative humidity)	0.08	0.07	0.09
Reduced mobility	Reduced ability to reach feed/water when motivated	0.04	0.03	0.04
Reduced mobility	Birds experiencing pain	0.04	0.03	0.05

Table 18: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all fast-growing types of broiler breeder. All quantities are to 2 decimal points.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	70.00	64.60	75.42
Conventional cages	Reduced behavioural repertoire	60.00	59.84	60.16
Conventional cages	Movement restriction	60.00	59.84	60.16
High stocking density	Reduced air quality	50.00	47.27	52.75
High stocking density	Disturbed rest periods	38.25	35.53	40.99
Conventional cages	Frustration	35.88	34.58	37.19
Conventional cages	Boredom	27.13	25.31	28.97
Poor housing design and allocation of resources	Frustration	14.00	12.24	14.40
Genetic selection for fast growth	Leg weakness (males)	5.63	4.51	6.82
Conventional cages	Abnormal behaviour (feather, spot pecking…)	4.80	4.27	5.35
Conventional cages	Injury through contact with other birds	0.75	0.53	0.99
Conventional cages	Injury through contact with physical structures	0.75	0.53	0.99
Ad lib feeding	Inability to walk / leg weakness	0.71	0.70	0.72
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.00	0.00	0.00

Table 19: Welfare impact of consequences of hazards in environment and housing of broiler breeders, ranked from highest to lowest score. These scores correspond to all slow-growing types of broiler breeder. All quantities are to 2 decimal points.

		WELFARE IMPACT		
HAZARDS	**Consequences**	**MEDIAN**	**MIN**	**MAX**
Barren environments	Reduced behavioural repertoire	87.50	82.06	87.70
Conventional cages	Reduced behavioural repertoire	70.00	69.84	70.16
Conventional cages	Movement restriction	70.00	69.84	70.16
Conventional cages	Frustration	70.00	66.35	73.67
High stocking density	Reduced air quality	50.00	47.27	52.75
Conventional cages	Boredom	50.00	44.86	55.18
Poor housing design and allocation of resources	Frustration	11.20	9.52	12.96
Conventional cages	Abnormal behaviour (feather, spot pecking…)	5.10	4.54	5.68
Genetic selection for fast growth	Leg weakness (males)	4.50	3.65	5.41
Conventional cages	Injury through contact with other birds	0.75	0.52	1.00
Conventional cages	Injury through contact with physical structures	0.75	0.52	1.00
Ad lib feeding	Inability to walk / leg weakness	0.29	0.29	0.30
Ad lib feeding	Metabolic disorders (ascites, SDS)	0.00	0.00	0.00

GLOSSARY AND ABBREVIATIONS

Artificial insemination	Collecting semen from a male and depositing it into the female genital tract.
Balanced breeding	Breeding for a combination of characteristics traits, concerning animal biology, animal health, efficiency, environment production, animal welfare and economy.
Beak trimming (de-beaking)	Removal of part of the upper (and sometimes also lower) mandible of the beak.
Best Linear Unbiased Prediction (BLUP)	A statistical method that gives the estimation of a Breeding Value of an individual for a specific trait.
Breeding value	The additive genetic value of an individual defined by the additive inheritable effects of all the genes an individual transmits to its offspring
Broiler	A type of chicken (*Gallus gallus domesticus*) bred for meat production
Broiler breeder	Birds of the parent (P) or grandparent (GP) generation in the system of producing broilers, i.e. chickens kept for meat production. Broiler breeders are sometimes also referred to as “multipliers”.
Cervical dislocation	A method of killing by stretching and twisting the vertebral column rapidly so that the spinal cord is torn and the blood vessels of the neck are ruptured.
Collective nest	Nest where several hens can lay their eggs simultaneously. Sometimes the expression ‘colony nest’ is also used for these types of nests.
Contact dermatitis	Comprises those diseases arising from skin contact with wet litter e.g. foot-pad dermatitis (pododermatitis), breast blisters (sometimes known as breast burns), hock burns
Correlation	A measure of how two traits relate to each other manifested by the way changes in one are accompanied by changes in the other. Correlation coefficients are expressed in the range –1.00 to +1.00.
Cross environment interaction	Correlation between the same trait measured in two environments. Used in connection with the interaction between genetics and environment.
Culling	The killing of birds that are: non- or low-producing, excess in number in relation to the production need, or sick or injured.
De-toeing	Removal of the dew (and sometimes also pivot) claw from the feet of breeder males to prevent damage to females during natural

	mating.
De-spurring	Removal of the spur bud on the back of the male chick's leg
Dubbing	Removal of all, or part, of the male comb.
Dwarf gene	Sex-linked, recessive gene that causes reduced weight and height
Elite lines	See pedigree lines
Environment	External factors that affect an animal
Estimated Breeding Value	An estimate of an animal's additive genetic value for a particular trait.
Feather sexing	Day-old chicks are sexed by visual inspection of the primary feathers
Genetic Correlation	Relationships between traits that arise because some of the same genes affect both traits or genes affecting two traits are closely linked. It reflects the way genetic values for the two traits co-vary.
Genetic diversity	High variety of alleles of genes within a population.
Genetic Progress	An increase in the average genetic merit of a population from one generation to the next for a particular trait as a result of selective breeding.
Genomic selection	Selection of animals to be used as parents of the next generation based on information provided directly from their genome.
Genotype	The actual genetic make-up of an individual as determined by its genes, may refer to a particular trait or the genome as a whole.
Genotype × Environment Interaction (GxE)	If various genotypes has a different ranking in different environments
Grand-parent stock	Broiler breeders two generations above the production (broiler) level. Offspring of Great Grandparent stock (GGP), which are the offspring of pedigree stock.
Half-sibs	Individuals who have the same sire or dam (i.e. half brothers and half sisters)
Heritability	Is the ratio of the genetic over phenotypic variance and reflects the proportion of a measured or observed trait that is transmitted to the offspring by genes that act in an additive manner.
Hybrid	Progeny produced by crossing two or more lines or breeds.
Lameness	An abnormal gait may or may not involve pain
Layer	A type of chicken (*Gallus gallus domesticus*) bred for efficient egg production

Leg weakness	A condition where the legs (including joints, bones, muscles, tendons etc) are affected and may predispose to lameness
Letal	Inherited gene that causes death
Lixiscope	Portable, handheld low-intensity X-ray apparatus giving a realtime imagine. Used among other for examination of bone fracture in small farm animals.
Marker assisted selection (MAS)	Selection using genomic/molecular markers with major effects for a particular trait.
Multiple Trait Selection	Selection for more than one trait.
Parent stock	Broiler breeders one generation above the production (broiler) level. Offspring of Grandparent stock (GP).
Peak production	The period in time when production (in this case the number of fertile eggs produced) is at its maximum.
Pedigree (Elite) stock	Birds used for breeding great grand-parent (GGP) stock and the generations prior to these.
Phenotype	The observed or measured expression of a trait for an individual. Phenotype is equal to genotype plus environment effects.
Polydipsia	Over-drinking
Progeny Testing	The evaluation of an individual's genotype and breeding value estimation using the performance records of its progeny.
Quantitative Trait Loci	The locus of a gene with a major effect on a quantitative trait.
Reaction Norm	In an extended G × E interaction situation with several genotypes and several environments a genotype may be more or less sensible to a given differences across environments than other genotypes. One spikes of the "reaction norms" of the genotype.
Selection	The process of deciding which animals will be parents of the next generation based on some pre-determined criterion.
Spiking	A procedure aiming at sustaining good fertility levels in broiler breeder flocks. At approx. 40 weeks of age inactive males in poor condition are removed and replaced by younger mature males.
Spot-brooding	Young chicks are reared in small enclosures under a heat source during the first days-week of life, instead of immediately given access to the entire area of the rearing house. Sometimes also referred to as zonal brooding.
Sudden death syndrome	Birds (broiler chickens) that die suddenly with no other obvious pathology.
Toe clipping	Removal of a specific toe at the first knuckle, for identification purposes.

Trait	Any measurable or observable characteristic of an animal.
Variation	The amount of difference observed or measured for a trait in a group of animals; may refer to phenotypic or genetic differences.
Vent-sexing	Day-old chicks are sexed by visual inspection of the cloacal area.

Abbreviations

AI	Artificial Insemination
AIAO	All In/All Out systems
AET	Apparent Equivalent Temperature
APEC	Avian Pathogenic *E. coli*
BB	Broiler Breeder
BLUP	Best Linear Unbiased Prediction
DOA	Dead on arrival
EE	Environmental Enrichment
FCR	Food Conversion Rate
FPD	Food Pad Dermatitis
GGP	Great Grand-Parent
GP	Grand-Parent
MAS	Marker Assisted Selection
QTL	Quantitative Trait Loci
TD	Tibial Dyschondroplasia

[i] Number of associated consequences
[ii] Likelihood of experiencing consequences if exposed to hazard (%)
[iii] Likelihood of exposure to hazard (%)
[iv] Welfare Impact