

Welfare assessment of turkeys (*Meleagris gallopavo gallopavo*) on farm

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The declarations of interest of all scientific experts active in EFSA's work are available at <https://open.efsa.europa.eu/experts>.

Abstract

This Scientific Opinion assesses the welfare of turkeys of all ages (*Meleagris gallopavo gallopavo*) on farm in relation to the type and condition of the litter, type and availability of enrichment (including covered veranda and outdoor range), space allowance, concentrations of ammonia and carbon dioxide, effective environmental temperature, group size, nest conditions, lighting conditions and hatchery conditions, by using 19 welfare consequences and associated animal-based measures (ABMs) for their assessment. In addition, the risks posed by the practices of flock thinning and removal of hens, mutilations (i.e. beak trimming, desnooding and toe trimming), artificial insemination (including semen collection) and feed restriction are assessed, with the latter two practices only in turkey breeders. The welfare consequences of breeding is assessed. Recommendations to prevent and/or mitigate relevant welfare consequences in fattening and breeder turkeys include increasing space allowance compared to the currently provided space, avoiding feed and water deprivation of newly-hatched poults for more than 48 h, and providing enrichment such as elevated platforms, straw-bales and a covered veranda. It is recommended to maintain dry litter conditions, i.e. below a threshold of 35%–40% humidity. Beak trimming, desnooding and toe trimming as well as the associated welfare consequences can be avoided if the recommended housing and management practices are implemented, e.g. increasing space allowance and providing suitable enrichment. It is recommended to discontinue flock thinning and avoid quantitative feed restriction, the latter currently practised in breeder toms. Also, it is recommended to place more emphasis on leg health and less on weight gain in genetic selection. The selected ABMs to monitor relevant welfare consequences at the slaughterhouse are total mortality, plumage damage, carcass condemnation, wounds, breast blisters and footpad dermatitis.

KEYWORDS

animal-based measures, mutilation, risk assessment, space allowance, turkeys, welfare

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SUMMARY

Background and Terms of References

The European Commission (EC) requested EFSA to provide a scientific opinion on the welfare of turkeys (including breeding turkeys and turkeys kept for meat production) based on the current body of scientific evidence. The first Term of Reference (ToR) requested a description of the most common husbandry systems and current practices for keeping turkeys in the European Union (EU). This ToR was addressed in a separate publication, 'Technical Report: Turkeys' (*Meleagris gallopavo gallopavo*) housing systems and management practices' (EFSA, 2026). The second ToR requested (a) an assessment of the welfare consequences of housing conditions for turkeys in relation to the risks associated with type and condition of the litter, the type and the availability of enrichment, the availability and conditions of outdoor ranges (including covered veranda), space allowance, environmental (exposure to ammonia, carbon dioxide, temperature) and light conditions, group size and mixed keeping of males and females; (b) a welfare assessment of turkeys kept for meat production considering the final body weight, average daily weight gain, the practice of thinning and the practices of feed and water restriction; (c) a welfare assessment of turkey breeders considering the age at onset of breeding, nest conditions, artificial insemination and the application of feed and water restriction; (d) the risk to welfare posed by hatchery conditions; (e) the risk to welfare associated with beak trimming and other mutilations (e.g., de-toeing and desnooding); and (f) the risks/benefits to welfare associated with breeding. The third ToR concerned the identification of the relevant welfare consequences and animal-based measures (ABMs) related to the housing systems, risk factors and the practices described in ToR1 and ToR2. The fourth ToR requested qualitative and, where applicable, quantitative recommendations to prevent or mitigate the welfare consequences for turkeys on farm identified in ToR3. Lastly, the fifth ToR requested an assessment of ABMs that could be collected at slaughterhouses to monitor on-farm welfare consequences for turkeys.

Data and methodologies

The welfare assessment was based primarily on peer-reviewed scientific literature, complemented by expert opinion and information gathered through an EFSA Public call for evidence, a stakeholder meeting, data from fact-finding missions in France, Germany and Italy, technical hearings and data from EFSA networks. A behavioural space model that accounts for the average time budget and the space required for specific behaviours was used to assess the minimum space allowance needed to perform stationary behaviours (standing, resting, sitting, feeding and drinking), dynamic behaviours (including only locomotion, foraging and exploration), wing flapping, dustbathing, other comfort behaviours (i.e. preening and wing/leg stretching) and strutting (only for turkey toms). The assessment also included the inter-individual distance. The parameters of the model were elicited through expert knowledge elicitations.

Assessment: hazards, relevant welfare consequences and measures for prevention and mitigation (ToR 2, 3 and 4)

Type and condition of the litter

The assessment identified the type and condition of litter as critical factors influencing turkey welfare. Inappropriate type or condition of litter can lead to the welfare consequences Resting problems, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Cold stress, Locomotory disorders (including lameness), Soft tissue lesions and integument damage and Respiratory disorders. The main hazard is excessive litter humidity, assessed as when the level is above 40%. Chopped straw and straw pellets are preferred for their high absorbency and cushioning, whereas less suitable materials (e.g. unchopped straw) pose greater risks due to reduced moisture retention. Litter quantity must be sufficient to support behavioural expression and moisture control. Flooring type influences litter performance and bird comfort, with concrete floors requiring adequate bedding to prevent foot injuries, while slatted flooring under drinkers can help maintain dry litter but reduces usable space for behavioural needs. Poor litter management (e.g. inadequate ventilation and heating, insufficient turning and replenishment of litter) leads to caking, ammonia accumulation in the litter and compromised welfare. Young poults and turkey breeders are particularly vulnerable due to their physiological sensitivity and prolonged exposure periods, respectively. Continuous monitoring of litter quality through visual scoring or automated systems, ventilation adjustment to environmental and flock conditions, regularly turning and replenishing litter and the use of suitable additives such as alum, sodium bisulfate and acidifiers are essential to maintain dry, friable litter. Corrective measures are partial litter replacement and the use of highly absorbent bedding materials.

Type and availability of enrichment (including covered veranda and outdoor range)

The assessment revealed that appropriate and sufficient environmental enrichment is essential to support behavioural expression as well as to prevent and mitigate the relevant welfare consequences Group stress, Resting problems, Locomotory disorders (including lameness) and Soft tissue lesions and integument damage in all categories of turkeys, including breeders. Elevated platforms are preferred to perches, particularly for heavier birds and should be designed for accessibility and comfort, with a recommended area of 0.15 m² per hen weighing 12 kg. Platforms approximately 0.6 m wide allow turkeys to line up in two rows, optimising surface use. Ramp access to elevated structures is recommended to facilitate

vertical movement and ease transitions. Foraging and exploratory materials, particularly edible and manipulable types like straw, pecking blocks and corn silage, are effective in reducing injurious pecking and promoting activity. Visual barriers provide shelter and reduce the risk of injurious pecking, while dust baths support comfort behaviour. Outdoor access and covered verandas contribute to complex, enriched environments that strongly support behavioural needs. Restricted access to enrichment increases competition and the risk of associated welfare consequences. However, quantitative data on the provision of enrichment remain limited.

Space allowance

Space allowance is a major determinant of turkey welfare because insufficient space directly leads to the welfare consequences Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour and Inability to perform exploratory or foraging behaviour. In addition, the welfare consequences Heat stress, Soft tissue lesions and integument damage, Gastroenteric disorders, Respiratory disorders and Locomotory disorders (including lameness) can indirectly be exacerbated through insufficient space allowance. A behavioural space model was applied to estimate the minimum space requirements for turkeys by calculating the planimetric area and inter-individual distance needed to perform key behaviours, based on body size and behavioural time budget. The space requirements for stationary behaviour in turkeys increase with slaughter weight, ranging from medians of 1047 at 7 kg to 1795 cm² at 25 kg. Dynamic behaviours require 1.56–1.61 times more space than stationary behaviours, with wing flapping demanding the most space. Strutting, performed only by toms, requires 1.43 times more space than stationary behaviours, reaching up to 2567 cm² at 25 kg. The inter-individual distances estimated by expert elicitation were 31.8 cm (90% certainty range: 17.2–60.8 cm) for hens and 42.3 cm (90% certainty range: 23.8–69.3 cm) for toms. These distances reflect the need to avoid physical contact during behavioural expression, particularly wing flapping. The maximum stocking density recommended for hens ranges from 14.4 kg/m² per hen at 7 kg target body weight to 26.2 kg/m² per hen at 16 kg target body weight, while for toms it ranges from 21.4 kg/m² per tom at 16 kg target body weight to 30.5 kg/m² per tom at 25 kg target body weight.

Concentrations of ammonia and carbon dioxide

Exposure to high concentrations of ammonia and carbon dioxide causes welfare consequences Respiratory disorders, with ammonia also resulting in Eye disorders. Ammonia levels above 25 ppm and carbon dioxide levels above 4000 ppm (measured at bird head height over 24 h) will cause these welfare consequences, while levels below 10 ppm and 2000 ppm respectively are not expected to impair the welfare of turkeys. Continuous monitoring of both gases is recommended to enable mitigation actions. Effective prevention relies on adequate ventilation (i.e. tailored to barn size, climate, turkey age and stocking density). Regarding ammonia, a balanced feed composition, adequate litter management and well-maintained watering systems are essential preventive strategies, whereas mitigation includes replenishing bedding material. A preventive strategy specific to carbon dioxide includes regular maintenance and inspection of heating systems.

Effective environmental temperature

The welfare consequences caused by inappropriate effective environmental temperature are Cold stress and Heat stress. Cold stress in turkey poults is prevented by pre-heating the barn before placement, maintaining adequate heating after placement and avoiding draughts. Heat stress is prevented and/or mitigated by tunnel ventilation, pad-cooling, fogging and reducing stocking density. Optimal environmental temperature (i.e. within the turkeys' thermal comfort zone) inside the barn should be ensured by regularly monitoring of the ventilation and heating systems.

Group size

Group stress is the welfare consequence associated with flock size. Yet there is no scientific evidence allowing the definition of a maximum group size that prevents its occurrence. Larger flocks require relative greater inspection effort and may hinder the detection of individuals experiencing impaired welfare. Strategies to minimise social disruption and improve distribution of resources (e.g. feeders, drinkers, point-source enrichment) are recommended to prevent Group stress in large flocks. Likewise, environmental modifications such as visual barriers, elevated structures, exploratory and foraging materials, adjusted lighting and sufficient access to feed and water are recommended to mitigate Group stress. Frequent monitoring of injurious pecking and agonistic interactions (i.e. ABMs for the assessment of Group stress) is advised.

Nest conditions

For turkey breeder hens during the production period, inadequate nest conditions lead to the welfare consequence Inability to perform pre-laying and nesting (maternal) behaviour, which may result in Group stress and Soft tissue lesions and integument damage. Hazards include insufficient nest provision, improper nest dimensions and design, malfunctioning trap/push-off mechanisms, inappropriate nesting materials and excessive light intensity above the nest boxes. Nest darkening during early lay is advised to support nesting behaviour. A maximum of four hens per nest is recommended to reduce competition and associated welfare consequences. Preferred nesting materials include peat, sand and wood

shavings. Frequent monitoring of nesting behaviour and nest mechanisms is recommended, especially at the start of lay. Trap and push-off mechanisms should be maintained to prevent gregarious nesting and broodiness.

The practices of flock thinning and removal of hens

Flock thinning involves removing a portion of birds for slaughter at scheduled intervals to prevent exceeding the targeted stocking density in the barn. In systems housing both toms and hens in separate areas on the same farm, the earlier removal of hens frees up space for toms to continue growing to their target slaughter weight ('removal of hens'). The welfare consequences associated with flock thinning and removal of hens increase the risk of turkeys being exposed to insufficient space allowance due to the initially high number of birds placed, causing the birds to potentially experience the welfare consequences Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Heat stress, Soft tissue lesions and integument damage, Gastroenteric disorders, Respiratory disorders and Locomotory disorders (including lameness). Additionally, the preparatory steps such as feed and water withdrawal, catching and the resulting social disruption are associated with increased risk of Handling stress, Sensory overstimulation, Prolonged hunger, Prolonged thirst, Group stress and Gastroenteric disorders. The EFSA experts recommend discontinuing flock thinning. It is recommended to avoid the practice of removal of hens unless the following is applied: (i) feed withdrawal should not exceed 6 h, (ii) feeder/drinker lines in separated hen and tom areas in the same house can be operated independently, (iii) biosecurity measures for equipment and personnel are applied and (iv) adequate resource distribution and enrichment are provided.

The practice of mutilations

Mutilation is the removal of or damage to an innervated part or parts of the body. In turkeys, the mutilations applied are beak trimming and toe trimming (in both sexes) as well as desnooding (only in toms). For beak trimming, a maximum of one-third of the upper beak is typically removed at hatch, while toe trimming affects the three forward-facing digits. The assessment concluded that beak trimming, toe trimming and desnooding cause the welfare consequence Soft tissue lesions and integument damage, with potential for acute and chronic pain, and Handling stress. Beak trimming may also result in Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Prolonged hunger and Prolonged thirst. In addition, toe trimming affects locomotion and balance, leading to Locomotory disorders (including lameness). Desnooding may impair thermoregulation and cause Heat stress. Beak trimming does not prevent injurious pecking but reduces the ability to inflict damage. Preventive and mitigation measures to avoid welfare consequences associated with keeping turkeys beak-, snood- and toe-intact are the provision of environmental enrichment, strategic genetic selection, appropriate light conditions, adequate space allowance and natural blunting or smoothing of the beak/claws. EFSA experts recommend that mutilations are phased out, though strategies to prevent injurious pecking and damage caused by intact toes should be implemented and optimised before the mutilations are phased out.

Lighting conditions

The assessment revealed that low light intensity, inappropriate photoperiods, inappropriate flickering and absence of daylight or UV-A are associated with the welfare consequences Group stress, Soft tissue lesions and integument damage, Resting problems, Locomotory disorders (including lameness) and Sensory under- and/or overstimulation. For prevention of these welfare consequences, a minimum light intensity of 10 lux at bird-eye level is recommended. A stable light-dark cycle with age-adjusted dark phases is advised to support circadian rhythms. Lighting programmes should follow gradual and predictable step-up and step-down schedules. UV-A exposure via daylight or artificial lighting is recommended to enable turkeys to make full use of the spectrum visible to them and reduce injurious pecking. Lighting equipment should avoid flicker perceptible by turkeys. Frequent monitoring of ABMs, such as plumage condition and resting behaviour, is essential to assess the adequacy of the lighting conditions.

The practices of artificial insemination and semen collection

Artificial insemination and semen collection are practised in turkey breeder hens and toms, respectively, during the production period. These practices are associated with the welfare consequences Handling stress, Soft tissue lesions and integument damage, Bone lesions, Reproductive disorders, Prolonged hunger and Group stress. Artificial insemination and semen collection cannot be avoided under current production systems, but the welfare consequences caused by the hazards can be mitigated. Feed withdrawal before semen collection beyond 6 h is considered to cause Prolonged hunger and Group stress. The first insemination of hens should occur only after sexual maturity, indicated by squatting behaviour. Insemination and semen collection should be performed by the same trained personnel to promote habituation and reduce Handling stress. Continuous flock-level monitoring is recommended to detect behavioural and production anomalies. Mechanical restraint and improper technique may cause Bone lesions and cloacal damage.

The practice of feed restriction

Feed restriction of turkey breeders is applied to control body weight and synchronise sexual maturity. During rearing, qualitative feed restriction may be applied to both sexes by reducing protein content, while during production, toms can be quantitatively restricted with fixed daily feed amounts down to 80% of ad libitum feed consumption. When quantitative feed restriction is applied, the birds will experience the welfare consequences Prolonged hunger and Group stress, although with the currently practised feed restriction level, the prevalence and severity remain uncertain. Preventive measures include ensuring nutrient adequacy and sufficient feed volume. Dilution of feed with insoluble fibre is recommended to prevent quantitative restriction and mitigate welfare consequences. Dividing toms into weight groups and adjusting feed accordingly can reduce competition and hunger. Sufficient feeder space per bird is essential to prevent Group stress. Monitoring growth trajectories and adjusting diets gradually further reduces the risk of welfare impairment.

Hatchery conditions

The assessment concluded that inadequate hatchery conditions are associated with the welfare consequences Umbilical disorders, Locomotory disorders (including lameness), Eye disorders, Sensory under- and/or overstimulation, Resting problems, Restriction of movement, Prolonged hunger, Prolonged thirst and Handling stress. Excessive egg storage duration increases the risk of Umbilical disorders, Locomotory disorders (including lameness) and Eye disorders. Lack of a diurnal light/dark cycle and excessive noise (> 90 dB) contribute to Sensory under- and/or overstimulation and Resting problems. Feed and water deprivation exceeding 48 h post-hatch leads to Prolonged hunger and Prolonged thirst. Inappropriate handling and equipment during hatchery procedures cause Handling stress and Restriction of movement. Preventive measures include maintaining a 12 h-light/12 h-dark schedule, minimising egg storage and providing feed, water or hydrogels within 48 h post-hatch. To move poults in the hatchery, conveyor belt speed changes above 0.4 m/s, drop heights over 280 mm and speeds above 27 m/min should be avoided. Regular staff training and system monitoring are recommended to reduce Handling stress.

Welfare aspects of genetic selection and breeding strategies

Genetic selection and breeding strategies influence turkey welfare both directly and indirectly, with the associated welfare consequences Locomotory disorders (including lameness), Restriction of movement, Soft tissue lesions and integument damage, Group stress, Prolonged hunger, Prolonged thirst, Respiratory disorders and Gastroenteric disorders. Overemphasis on productivity traits like body weight and breast meat yield is linked to unfavourable genetic correlations with health and welfare traits. Breeding goals, especially with increased emphasis on leg health compared to productivity, are recommended to mitigate this hazard. Welfare improvements should integrate genetic selection with better housing and management. Lastly, data transparency and integration of automatically recorded individual behavioural traits are also advised.

Animal-based measures collected on farm and at the slaughterhouse to assess the level of welfare of turkeys on farm (ToRs 3 and 5)

For each welfare consequence identified as relevant for turkeys in relation to the housing systems, practices and hazards described in ToR1 and ToR2, ABMs for their assessment were identified and described. For ABMs (to be) collected in slaughterhouses, the assessment revealed that the following ABMs are indicative of the level of welfare of turkeys on farm: footpad dermatitis, plumage damage, carcass condemnations, wounds and breast blisters. This was also assessed to be the case for the total mortality of turkeys on farm, which is communicated to the slaughterhouse for each batch of turkeys received. These ABMs are associated with the welfare consequences Soft tissue lesions and integument damage, Restriction of movement, Locomotory disorders (including lameness), Gastroenteric disorders, Resting problems, Prolonged hunger, Heat stress, Inability to perform exploratory or foraging behaviour, Group stress and Respiratory disorders. It is important to note that ABMs that can be collected and measured at the slaughterhouse do not cover all the relevant welfare consequences on the farm. Assessment of ABMs at slaughter lacks harmonised protocols across EU Member States. While automated methods for footpad dermatitis exist and are used in some countries, their reliability and validation level remain largely unclear. Technology Readiness Levels vary across ABMs, with footpad dermatitis being the most advanced. To develop standardised scoring systems, it is recommended to validate both manual and automated assessment methods and. Training and calibration of assessors are essential to ensure consistent and accurate welfare monitoring.

1 | INTRODUCTION

1.1 | Background and Terms of Reference as provided by the European Commission

1.1.1 | Background

In accordance with the Farm to Fork Strategy, published on 20 May 2020, the Commission is working on the revision of the EU animal welfare legislation. This includes the following acts:

1. Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes¹;
2. Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens²;
3. Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves³;
4. Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs⁴;
5. Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production⁵;
6. 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 1255/97⁶;
7. Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.⁷

There is currently no specific EU animal welfare legislation covering turkeys, however Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes⁸ applies for this animal species. In addition, in 2001 the Council of Europe has adopted a specific Recommendation concerning turkeys,⁹ which is incorporated into the EU animal welfare acquis by Council Decision 78/923/EEC.¹⁰

In 2019 EFSA has published two scientific opinions one on the welfare of slaughter and the other on on-farm killing of poultry species (including turkeys). In 2022 EFSA has published a scientific opinion on transport of animals in containers including turkeys. However, previously EFSA has not published scientific opinions on the welfare of turkeys on farm.

Against this background, the Commission would like to request the EFSA to review the available scientific publications and other sources to provide an updated and sound scientific basis for possible future EU specific legislation on the welfare of turkeys on farm.

This request is about the protection of turkeys *Meleagris gallopavo gallopavo* on farm, covering turkeys of all ages (breeding turkeys and turkeys kept for meat production) including hatchery conditions.

1.1.2 | Terms of Reference

The Commission therefore considers opportune to request EFSA to give an independent view on the protection of turkeys.

A The Commission requests EFSA to deliver a technical report in accordance with Article 31 of Regulation (EC) No 178/2002¹¹ on the elements below:

Request 1. A review of the most common husbandry systems and current practices for keeping turkeys *Meleagris gallopavo gallopavo* on farm, covering turkeys of all ages (breeding turkeys and turkeys kept for meat production) including hatchery conditions in the EU.

This is to include description of the types of housing, litter availability, access to outdoors (including covered veranda), stocking density applied, the enrichment provided (perches, platforms, pecking objects, etc.) and the light scheme. It also includes the practices of thinning in farms of turkeys kept for meat production, the separation of sexes and mutilations. It includes the description of the hatchery conditions and the use of cages and breeding practices (including artificial insemination) in turkey breeders.

¹OJ L 221, 8.8.1998, p. 23.

²OJ L 203, 3.8.1999, p. 53.

³OJ L 10, 15.1.2009, p. 7.

⁴OJ L 47, 18.2.2009, p. 5.

⁵OJ L 182, 12.7.2007, p. 19.

⁶OJ L 3, 5.1.2005, p. 1.

⁷OJ L 303, 18.11.2009, p. 1.

⁸OJ L 221, 8.8.1998, p. 23.

⁹<https://www.coe.int/en/web/cdcj/2001-rec-turkeys>.

¹⁰OJ L 223, 17.11.1978, p. 2.

¹¹OJ L31.1 28.8.2002, p. 24.

B The Commission requests EFSA to deliver a scientific opinion in accordance with Article 29 of Regulation (EC) No 178/2002 for keeping turkeys *Meleagris gallopavo gallopavo* on farm, covering turkeys of all ages (breeding turkeys and turkeys kept for meat production) focusing in particular on the issues identified below:

Request 2. Assess

- a. for turkeys kept for meat production, turkey breeders and poults, the risk to welfare posed by the following risk factors and practices: the type and condition of the litter, type and presence of enrichment, availability and condition of outdoor space (including covered veranda), space allowance, environmental (ammonia, CO₂, temperature) and light conditions, group size and mixed keeping of males and females;
- b. for turkeys kept for meat production, the risk to welfare posed by the following risk factors and practices: the final weight, average daily weight gain, the practice of thinning and the practices of feed and water restriction.
- c. for turkey breeders, the risk to welfare posed by the following risk factors and practices: age of onset of breeding, nest conditions, artificial insemination and the practices of feed and water restriction;
- d. the risk posed by the hatchery conditions, on the welfare of turkeys of all ages relevant;
- e. the risk to welfare associated with beak trimming and other mutilations where performed (e.g. de-toeing and de-snooding);
- f. the breeding and genetic traits that improve and/or impair welfare;

Request 3. Identify the relevant welfare consequences of the housing systems and the risk factors and practices described in Request 1 and 2, by using animal-based measures for the assessment of these welfare consequences.

Request 4. Provide qualitative and, where applicable, quantitative recommendations to prevent or mitigate the welfare consequences on farm identified in Request 3;

Request 5. Assess and define suitable animal-based indicators collected at the slaughterhouse to monitor the level of welfare of turkeys on farm.

1.2 | Interpretation of the Terms of Reference

As part of a comprehensive evaluation of the animal welfare legislation, the European Commission (EC) asked EFSA to give an independent view on the protection of turkeys. In particular, the EC mandated EFSA to develop a Scientific opinion (SO), in accordance with Article 29 of Regulation (EC) No 178/2002, for keeping turkeys *Meleagris gallopavo gallopavo* on farm, covering turkeys of all ages (i.e. breeding turkeys and turkeys kept for meat production), including poults.

This SO aims at addressing the Term of Reference (ToR) B, Requests 2 to 5 and concerns the assessment of the welfare of turkeys on farm, whereas the killing of turkeys on farm is not part of the request. It needs to be noted that ToR A, request 1 of the mandate, on the most common housing systems and current practices for keeping turkeys has already been addressed in the relevant EFSA Technical Report which represents the basis for the welfare assessment performed in this SO.

It is worth to highlight that there are no legislative requirements specific on the protection of turkeys on farm on the level of the European Union (EU); whereas in some EU Member States (MSs) there are specific national legislations. In the EU MSs where there is no specific legislation, Council Directive 98/58/EC concerning the protection of animals kept for farming purposes is applied after being transposed into national legislative acts. The Recommendation concerning turkeys from European Convention for the Protection of Animals kept for Farming Purposes adopted on 21 June 2001¹² included a series of recommendations for certain aspects such as (i) stockmanship and inspection; (ii) enclosures, buildings and equipment, (iii) management; (iv) changes of genotype; (v) changes of phenotype. This is the first EFSA SO addressing the welfare of turkeys on farm. Previously, EFSA has produced SOs on the welfare of turkeys during slaughter (EFSA AHAW Panel, 2019) and during transport (EFSA AHAW Panel, 2022a).

In the current SO, EFSA addressed the EC mandate by focusing mainly on the adverse effects on welfare (so called 'welfare consequences'). This is specifically requested in ToR B, Requests 2a where EFSA is tasked to assess the 'risks to welfare' that are related to absence, insufficiency or inappropriateness of factors such as litter, enrichment, space for the different categories of turkeys or to specific practices (e.g. thinning, artificial insemination, mutilations), whereas Request 2f is about breeding strategies, genetic traits and their welfare implications.

The EC requested EFSA to assess different aspects of keeping turkeys (*Meleagris gallopavo gallopavo*) of all ages. The turkey categories reviewed in this mandate include poults, fattening turkeys and turkey breeders, as described by EFSA (EFSA, 2026). In particular, in the context of this SO the following definitions apply:

Turkey poult is a newly-hatched turkey up to 7 days of life, a period during which the bird is unable to thermoregulate.

Turkeys kept for meat production are kept between 8 days of age until they are slaughtered. The slaughter weight and age are different between hens and toms, between countries and between heavy (e.g. genotype B.U.T. 6) and medium (e.g. genotype B.U.T. premium) lines. They can also be called meat turkeys or fattening turkeys.

¹²<https://www.coe.int/en/web/cdcj/2001-rec-turkeys>.

Turkey breeders are kept for reproduction and production of new generations of (fattening or breeding) turkeys. Turkey breeders are differentiated in immature and mature depending on the physiological stage. ‘(Sexually) immature breeders’ are young birds in their growing period that are kept later for breeding purposes. ‘Mature breeders’ are subdivided into the following four descriptive categories:

Pedigree breeders are breeders from the selected pure line. The purebred lines are reared in closed populations. They have known pedigree and individual performance records, that allow their individual genetic and/or genomic evaluation.

Great-grandparent breeders are breeders from the selected line with unknown or known pedigree records. In the latter case, they can play the role of a mirror population of the selected line. Their offspring are primarily used as Grandparental breeders in the production of Parental breeders. This stage will only be needed in the production scheme if the commercial product market size is extensive, as it is a way to multiply the number of offspring at the subsequent stages.

Grandparent breeders are breeders from selected pure lines, deriving from great-grandparent breeders or pedigree breeders directly, that have known or unknown pedigree. If a great-grandparent generation is not present, grandparents would be created from the pedigree generation. This is the first stage of the female and male line for production of the terminal offspring (commercial product) which are used for production of meat for human consumption.

Parent breeders are breeders of unknown pedigree with each sex being either an inter-cross of two pure lines or from a pure line. Their offspring are intended for production of meat for human consumption and will not be kept as breeders themselves.

In turkeys, it is common to house the females (hens) and males (toms) separately. Both sexes can be reared for breeding and fattening purposes (for more details see EFSA, 2026).

The housing systems considered in the current assessment are those described in the Technical report by EFSA (2026): (i) hatcheries, (ii) indoor floor systems, (iii) indoor floor systems with covered verandas and (iv) indoor floor systems with outdoor access (or a combination of the last two systems).

To address the first set of ToRs (**ToR B, Requests 2a, b and c**) listed in the mandate, for each turkey category and factor or practice indicated in the mandate, a list of hazards was identified and described. The hazards considered by expert opinion as the most relevant were assessed in terms of the welfare consequences that they could cause and in relation to the specific housing systems and practices where they could occur. The practices assessed in this SO are described in the EFSA Technical report (EFSA, 2026).

In **ToR B, Request 2a**, the EC listed examples of **enrichment** in turkey production, such as perches, platforms and pecking objects. In the context of this SO, the EFSA AHAW Panel defines enrichment as ‘housing elements (either single type or multiple types combined in a complex system) that increase the occurrence and variety of species-specific and motivated behaviours’ (Riber et al. (2018) (see Section 3.2.2). The EFSA AHAW Panel emphasises there is a growing trend in the scientific community towards viewing housing elements necessary for meeting basic behavioural motivations as ‘mandatory housing requirements’ rather than ‘enrichment’. Consequently, many elements traditionally seen as enrichment would no longer fit this definition. For instance, perches and platforms are essential for turkeys to perform the highly motivated behaviour of roosting; therefore, according to the described trend, they would not be considered enrichment, but they are still included and referred to as enrichment in the section on enrichment (Section 3.2.2) to accommodate the request from the EC. In addition, an outdoor area, i.e. outdoor range or covered veranda, is considered part of complex enriched environments. Therefore, the assessment of the availability and condition of outdoor space (including covered veranda) on turkey welfare, as requested by the EC, is included in Section 3.2.2.

In **ToR B, Request 2a**, among other factors, the EC asked for the assessment of the risk posed by **temperature** to turkeys of all ages. In the context of this SO, the EFSA AHAW Panel considers the factor ‘temperature’ of the mandate as ‘the effective environmental temperature’, which is largely determined by a combination of air temperature and humidity (EFSA AHAW Panel, 2022a), and has been dealt with it in the respective Section 3.2.6.

In **ToR B, Request 2a** the mandate requested to assess also the risk to welfare posed by the **mixed keeping of males and females**. This was interpreted as a scenario in which the turkey males and the turkey females are reared in the same barn or farm in separate areas, and the females are sent to slaughter about 4 to 6 weeks earlier than the males. Following the removal of the females, males are given access to the space previously occupied by the females for the remaining weeks until slaughter. This scenario was named ‘removal of hens’. Furthermore, the mandate requested to assess the risk to welfare posed by the practice of **thinning** (in **ToR B, Request 2b**). The term thinning was interpreted as the planned removal of a proportion of birds from a flock before the end of the production cycle (i.e. ‘flock thinning’). This scenario was assessed together with the removal of hens as the hazards have largely overlapping welfare consequences (see Section 3.2.9).

To address **ToR B, Request 2c** in relation to the practice of **artificial insemination**, the assessment focused on welfare consequences experienced by breeder toms and hens subjected to the semen collection and insemination procedures. By keeping the breeder toms and hens separated, breeder toms and hens are prevented from performing sexual behaviour; however, the thwarting of expressing natural sexual behaviour was not included in this assessment, as this was not requested in the mandate. Ethical considerations linked to this practice were not taken into account as they fall outside EFSA’s remit.

With specific reference to mutilations, the EC mandate asked EFSA to assess the welfare consequences of beak trimming and other practices (e.g. de-toeing and desnooding) (**ToR B, Request 2d**). From the outcomes of an exercise conducted with the EFSA Networks on animal welfare, it was clarified that de-toeing is not performed in turkeys in EU MSs countries. This was also confirmed in the fact-finding studies conducted in Italy and France (European Commission, 2024a). These practices are normally applied in day-old poults, although they are associated with welfare consequences also in the other

categories of turkeys (toms and hens kept for meat production and breeding). In this SO, mutilations were assessed both in relation to the welfare of poults (i.e. in relation to immediate pain) and of turkeys kept for meat production and turkey breeders, when chronic pain or discomfort can be experienced (see Section 3.2.10). The biological functions of the removed body parts were considered in this assessment in relation to the relevant welfare consequences; however, however, the ethical dimension of animal integrity was deemed to fall outside the scope of this SO.

To address **ToR B, Request 2e**, on the breeding and genetic traits that improve and/or impair welfare, it was necessary to first identify which traits are used by turkey breeding companies and assess whether the traits could have a role in the welfare consequences. Due to the limited information available in literature, breeding companies of turkeys were consulted for explanations on the genetic traits, selection and specific practices and their links to welfare or behaviour. In this SO, welfare aspects of genetic selection and breeding practices are considered in terms of what is currently done or possible in the near future. Ethical considerations linked to these practices were not taken into consideration as they fall outside EFSA's remit. In this context, genetic selection focused on defining traits, determining which traits to include and selecting turkeys that exhibit desirable characteristics. Breeding practices can be considered more broadly to include the process of trait collection, breeding decisions, statistical modelling and formulation of breeding goals. When discussing results of specific studies in this section, the wording of the original study is used in terms of the interpretation of values as low, moderate or high when it comes to heritability or genetic correlations between traits. When discussing relationships between traits, correlations can be positive or negative, however, this gives little information. In publications, geneticists often speak of antagonistic or unfavourable correlations (sometimes interchangeably) between traits to aid in interpretation. In this SO, it has been chosen to refer to unfavourable relationships as this could occur when correlations between two traits are both positive or negative.

EFSA was also asked to identify the relevant welfare consequences (as indicated by animal-based measures (ABMs)) that turkeys may experience in relation to the housing systems, practices and factors listed under Requests 1 of ToR A and 2 of ToR B (**ToR B, Request 3**). To address this ToR, a list of specific welfare consequences was developed, starting from the set of welfare consequences previously produced by EFSA (EFSA AHAW Panel, 2022b) and focusing on the relevance for turkey welfare. These consequences may lead to negative affective states such as fear, pain or distress. Their relevance to specific hazards or management practices was then evaluated by the EFSA experts, considering severity, duration and frequency (see Section 2.2.2). For each of these welfare consequences, one or more ABMs were identified and reported in Section 3.1 with their definition, description and interpretation. It needs to be noted that the ABMs that were included in this assessment were not selected on the basis of specific criteria (e.g. on ABM's characteristics or on the purpose of their use) but are the ones that were retrieved in the poultry scientific literature or reported in grey literature as commonly used in practice when searching for evidence on the hazards and practices listed in the mandate (ToR B, Requests 2a-f). The identification of the ABMs helps to describe and assess the welfare consequences and to assess the relationship with the mandate factors and practices. Birds experiencing one welfare consequence can be subjected to a secondary one. The latter can be assessed by diverse (secondary) ABMs. In this SO, ABMs are reported in relation to the primary associated welfare consequence. The welfare consequences identified as relevant for turkeys are described in Section 3.1, with the related ABMs.

To address **ToR B, Request 4**, quantitative or qualitative recommendations in form of resource- and/or management-based measures allowing the prevention or the mitigation of the identified welfare consequences were provided in the assessment of the hazards related to each factor and practice listed in the mandate (see Sections 3.2.1–3.2.15). The effect of each factor or practice on turkey welfare was considered separately. However, quantitative recommendations are subject to considerable uncertainty because they do not consider the interaction between factors, practices and confounding in study designs. Therefore, the recommendations assume the other factors and practices as being adopted following good practice or according to the other recommendations made in this SO.

Finally, **Request 5 of ToR B** focuses on the assessment of the ABMs which can be collected at slaughterhouses to monitor the level of welfare of turkeys on farm. The ABMs currently reported to be used in the EU MSs (EFSA, 2023) are described, together with information on the feasibility to measure the ABMs, their relevance and the link to the welfare consequences experienced on farm. Both breeders and fattening turkeys were considered. As the outcome of this ToR, a set of ABMs suitable to be measured at slaughter was provided (see Section 3.3).

2 | DATA AND METHODOLOGIES

2.1 | Data

2.1.1 | Data from literature

The information contained in the papers selected as relevant from the literature searches described in Section 2.2.1 and from additional scientific and grey literature identified by the EFSA experts was used for the narrative description and the assessment in this SO.

It needs to be noted that for the majority of factors and practices listed in the mandate, the available scientific literature on the welfare of turkeys is limited or scarce. To fill these gaps, the EFSA experts reviewed the grey literature available on turkeys (e.g. manuals of breeding genetic companies on turkey breeders) and the scientific evidence available on other

poultry species, in particular on the chicken (*Gallus gallus domesticus*). When considered relevant, the suitable information was reported in this SO and the related sources were referenced.

2.1.2 | Data from stakeholder consultation

In addition, under the framework of the EFSA Engagement strategy for animal welfare mandates (EFSA, [online](#)), a series of activities was carried out to complement the information retrieved from the literature and as additional sources of information for the EFSA experts' group discussion and consensus. These activities were: a stakeholder meeting, a public call for evidence, an ad-hoc technical hearing, consultations of the EFSA Networks on animal welfare (EFSA, [2023](#), [2024](#)) and participation in a fact-finding mission (European Commission, [2024a](#)).

2.1.2.1 | Data from stakeholder meeting

Early after the reception of the EC mandate by EFSA, a stakeholder meeting was conducted on 7th November 2023 in Brussels in which the ToR of the mandate were presented along with the stakeholder engagement steps. A total of 45 participant organisations attended the meeting, with representatives from several stakeholders and interested parties, including from the EC and 12 countries, with participation from industry, Non-Governmental Organizations (NGOs), Academia, Research Institutes and competent authorities. Information shared during the meeting was collected and made available to the EFSA experts and referenced accordingly in this SO, when relevant for the assessment. The full list of participant organisations¹³ and the presentations¹⁴ provided during the stakeholder meeting are available on the EFSA website.

2.1.2.2 | Data from public call for evidence and submissions

In line with its policy on openness and transparency, and to receive any relevant evidence on the welfare of turkeys on farm from the scientific community and all interested parties, EFSA launched a public call for evidence from 7 December 2023 to 31 January 2024. The document presenting the public call for evidence included different ToRs of the EC mandate and is available at Open EFSA (<https://connect.efsa.europa.eu/RM/s/consultations/publicconsultation2/a0ITk0000001qRB/pc0741>).

The public call for evidence focused on eight areas: (1) husbandry systems of turkeys kept for meat production, turkey breeders, hatchery conditions and turkey poults, (2) breeding of turkeys and its impact on welfare, (3) space allowance in different husbandry systems, (4) environment conditions and environment enrichment, (5) the practice of mutilations in turkeys, (6) separation of turkey toms and turkey hens in the barn, (7) the practice of thinning in turkeys kept for meat production and (8) welfare assessment in turkey farming.

Twenty-four stakeholders, from eight countries, submitted 89 comments with 99 attachments and lists with 24 publications (for more details on the respondents, see [Appendix D](#)). Out of these, only the relevant comments and publications were considered by the EFSA experts in this assessment, and cited in this document as appropriate ([Appendix D](#) Public call for evidence for instructions on how to retrieve the information submitted by stakeholders). In total, 19 submitted inputs were included in the assessment. When information was provided in a language different than English the e-Translation tool¹⁵ of the EC was used to translate the inputs into English. The full list of submissions, including their attachments, is available at Open EFSA (<https://open.efsa.europa.eu/consultations/a0cTk00000024ifIAA?search=turkey>).

The data provided through the public call for evidence reflect a variety of reported practices concerning the welfare of turkeys. The received information was considered 'as is' when informative for the assessment and was not verified or validated by EFSA.

In addition, AVEC-ELPHA representatives submitted project reports on 8th July and 7th September 2025.

2.1.2.3 | Data from fact-finding studies on turkey sector

EFSA participated in the fact-finding mission to collect information on the national system for the protection of turkey welfare on farm in Italy, conducted from 28 February to 13 March 2024. EFSA was involved in the online and in-situ visits to one parental breeder farm during rearing and one parental breeder farm during production, one hatchery and three turkey fattening farms of males and females, as well as a slaughterhouse of turkeys. The results of the fact-finding study mission have been published (European Commission, [2024a](#)). In addition, two other fact-finding missions, where EFSA did not participate, took place in May and June 2024 in France and Germany, respectively (European Commission, [2024b](#), [2025](#)). The results of these fact-finding missions have been used and referenced accordingly throughout this SO.

¹³See 'List of participant organisations' under the 'Documents' section in <https://www.efsa.europa.eu/en/events/stakeholder-meeting-welfare-beef-cattle-and-turkeys-farming-practices-and-data>.

¹⁴See 'Presentations' under the 'Documents' section in <https://www.efsa.europa.eu/en/events/stakeholder-meeting-welfare-beef-cattle-and-turkeys-farming-practices-and-data>.

¹⁵https://commission.europa.eu/resources/etranslation_en.

2.1.2.4 | *Data from technical hearing with a turkey breeding company and EFFAB*

EFSA conducted a technical hearing with EFFAB and Aviagen ®Turkeys in October 2024 in the context of a meeting of the EFSA WG on the welfare of turkeys on farm. Information on genetic traits, selection and specific practices (e.g. artificial insemination, feed restriction) was provided and discussed. When this information was used for the current assessment, it was reported in this SO as ‘personal communication’.

2.1.2.5 | *Data from the EFSA networks on animal welfare*

Practical information on the current use of mutilation practices applied to turkeys and of ABMs monitored at turkey slaughter to assess on-farm welfare in the EU MSs was gathered through specific exercises with the members of the EFSA Networks dealing with animal welfare topics during their annual meetings carried out in 2023 and 2024. The description and the results of these exercises are published in EFSA supporting publications (2024) and have been used to inform the assessment of the risks to welfare posed by mutilations in turkeys (to address ToR B, Request 2c of the mandate; EFSA, 2024) and of the ABMs to collect at the slaughterhouse to monitor the level of welfare of turkeys on farm (ToR B, Request 5; EFSA, 2023), respectively.

2.2 | Methodologies

This SO follows the protocol detailed in the methodological guidance that was developed to deal with all the mandates in the context of the F2F strategy revision (EFSA AHAW Panel, 2022b). According to the protocol, EFSA translated the assessment questions into more specific sub-questions. These are interrelated, meaning that the outcome of each sub-question is necessary to proceed to the next sub-question. The approach to develop the sub-questions is based on using both evidence from the scientific literature and expert opinion. The protocol with the translation of the assessment questions into sub-questions is mapped in Table A.1 of Appendix A. Table A.2 in Appendix A visualises the approach that was followed for each assessment question.

2.2.1 | Literature search

Extensive literature searches were performed to retrieve studies with relevant information on turkeys to address the Requests listed under ToR B of the mandate. The searches were restricted to records published without time restriction till the day of the search which depending on the topic was in 2024 or 2025. The retrieved information was saved and relevant results (records) appearing at a later stage were screened and added to the pool of papers available to the experts. In addition, relevant articles, review articles, websites and key reports were checked for further relevant articles. EFSA experts were invited to propose any additional relevant publications they were aware of, until the information was considered sufficient to undertake the assessment. Details of the literature search strategies supporting the process are provided in Appendix B. All publications relevant for this SO were included in an EndNote 21 Library.

2.2.2 | Identification of the relevant welfare consequences and related ABMs

In ToR B, Request 3, EFSA was asked to identify the relevant welfare consequences of the housing systems and the factors and practices described in ToR B, Requests 1 and 2, and assess these welfare consequences by using ABMs. As outlined in the protocol (see Appendix A), 26 of the 33 welfare consequences identified by EFSA in the context of the F2F mandates (EFSA AHAW Panel, 2022b), were deemed applicable to turkeys (see Table 1). As outlined in the protocol (see Appendix A), 26 of the 33 welfare consequences identified by EFSA in the context of the F2F mandates (EFSA AHAW Panel, 2022b), were deemed applicable to turkeys (Table 1).

TABLE 1 Welfare consequences applicable to turkeys from the list of 33 welfare consequences defined by EFSA in the context of the F2F mandates (EFSA AHAW Panel, 2022b). The welfare consequences marked with an asterisk (*) are the relevant ones for the current mandate (see also Section 3.1).

1. Bone lesions (including fractures and dislocations)	14. Metabolic disorders
2. Cold stress*	15. Muscle disorders
3. Eye disorders*	16. Predation stress*
4. Gastroenteric disorders*	17. Prolonged hunger*
5. Group stress*	18. Prolonged thirst*
6. Handling stress*	19. Reproductive disorders
7. Heat stress*	20. Respiratory disorders*

(Continues)

TABLE 1 (Continued)

8. Inability to express pre-laying and nesting (maternal) behaviour*	21. Resting problems*
9. Inability to perform comfort behaviour*	22. Restriction of movement*
10. Inability to perform exploratory or foraging behaviour*	23. Sensory under- and/or overstimulation*
11. Inability to perform play behaviour	24. Skin disorders (other than soft tissue lesions and integument damage)
12. Isolation stress	25. Soft tissue lesions and integument damage*
13. Locomotory disorders (including lameness)*	26. Umbilical disorders and hernias*

Out of these 26 welfare consequences, those relevant for the current mandate were selected based on expert opinion. The elicitation consisted of a qualitative structured expert consensus exercise, as a quantitative method was not possible due to lack of published data on welfare consequences in turkeys. Initially, EFSA experts independently classified the relevance of each welfare consequence by qualitatively evaluating its severity, duration and frequency of occurrence/prevalence in relation to the factors and practices listed in the mandate in ToR B, Requests 2a-f. The individual assessment was followed by group discussion to reach consensus on the final list of relevant welfare consequences.

2.2.3 | Assessment of suitable ABMs collected at the slaughterhouse to assess the level of welfare of turkeys on farm

In ToR B request 5, EFSA was asked to provide a list of ABMs to be collected in slaughterhouses that can be indicative of the welfare of turkeys on farm.

To identify the most suitable ABMs, a structured procedure was followed which was consistent with previous EFSA SO responding to similar requests from the EC (EFSA AHAW Panel, 2023a, 2023b, 2023c). The current assessment was based both on expert knowledge and data from scientific literature. Additional details on the methodological steps are provided in the following text.

The starting point was a list of 19 ABMs selected as potentially relevant ABMs for measurement at slaughter in fattening and breeding turkeys. These ABMs and their descriptions were identified with the support of the EFSA experts on the basis of existing literature (AWIN, 2015; EFSA AHAW Panel, 2023a, 2023b; Welfare Quality®, 2009). For each ABM the most suitable time of assessment (i.e. *ante-* or *post-mortem*) was also proposed.

To gather information on their use in practice, the 19 ABMs were discussed by the EFSA Network of the National Contact Points (NCPs) for scientific support under Art 20 of Council Regulation (EC) 1099/2009, in the context of an exercise during the annual Network meeting of 2023. The information collected included the following points: which ABMs are currently recorded during *ante-* and *post-mortem* inspections of turkeys kept for meat production, whether electronic databases exist for recording these ABMs, the feasibility of recording the ABMs and the availability of automated systems for ABMs' collection and assessment.

During the meeting, Network members were asked to prioritise the provided ABMs classifying them as essential, desirable or not important. As a result of this exercise, a set of ABMs considered essential and desirable for monitoring and recording at the slaughterhouses was produced (for more details on the exercise during the scientific NCPs Network meeting, see EFSA, 2023).

Following the inputs gathered through the 2023 NCPs Network meeting, and on the basis of EFSA experts' knowledge on the topic, the ABM swollen toes (*post-mortem*) was added to the initial list of 19 ABMs, and it was specified that plumage damage was best assessed after bleeding and before scalding. Table 2 lists the 20 ABMs assessed to address this ToR.

TABLE 2 List of ABMs potentially relevant to collect in slaughterhouses for monitoring the level of welfare on turkey farms produced by the EFSA's experts, and indication of the preferred time of assessment (*ante-* or *post-mortem*). Descriptions of ABMs are available in Section 3.3 and EFSA (2023).

ABMs in turkeys			
Ante-mortem		Post-mortem	
1	Dirtiness	1	Dirtiness (before scalding)
2	Wounds	2	Eye condition (before scalding)
3	Fractures (e.g. legs and wings)	3	Breast blisters and/or breast buttons
4	Runts	4	Carcass condemnations
5	Eye condition	5	Footpad dermatitis
		6	Hock burns
		7	Wounds
		8	Bruises

TABLE 2 (Continued)

ABMs in turkeys		
<i>Ante-mortem</i>		<i>Post-mortem</i>
	9	Red or inflamed skin
	10	Plumage damage (after bleeding and before scalding) ^a
	11	Fractures (e.g. legs and wings)
	12	Leg condition
	13	Swollen toes ^b
	14	Mutilation of the toes and/or spur
	15	Total mortality on farm

^athis nuance in the parenthesis was added by the EFSA experts.

^bthe ABM was added by the EFSA experts.

A semi-quantitative consensus exercise evaluating the 20 ABMs of [Table 1](#) was carried out by the EFSA experts. The exercise consisted of two steps: (i) screening of ABMs and (ii) selection of ABMs.

The screening was carried out on the basis of four pre-defined yes/no (screening) criteria:

1. Relevance to animal welfare: *Is the ABM relevant to the welfare consequences defined in this opinion and not only to production and meat quality aspects?*
2. Relationship with the farm (not with transport or lairage): *Is the ABM indicative of a welfare consequence on farm and not caused or masked by transport, lairage and slaughter conditions?*
3. Existing data in literature: *Do scientific publications describe the ABM detailing methodologies, prevalence and the relation with on-farm welfare consequences?*
4. Feasibility for large-scale collection: *Is the ABM already routinely collected or is there evidence that it could be collected in a national programme?*

As a precautionary principle, if consensus among experts was not reached, the criterion was considered a 'Yes'. Only ABMs that received a 'Yes' for all of the four screening criteria listed above progressed to the second step (selection).

In the second step, the shortlisted ABMs from the list in [Table 2](#) were evaluated and ranked based on a second set of four (selection) criteria.

The four (selection) criteria used in step 2 were:

1. Welfare consequences (C1): The experts identified which welfare consequences on farm (from the ones applicable in turkeys, see [Table 1](#), Section 2.2) could be associated with the shortlisted ABMs. Each ABM was scored according to the number of different welfare consequences associated. In order to assign a score, first the percentage of welfare consequences associated with the ABM was calculated out of the total number of welfare consequences applicable in turkeys ($n=26$). Four scores were identified on the basis of percentage ranges: Score 1: from 1% to 14%; Score 2: from 15% to 29%; Score 3: from 30% to 44%; Score 4: from 45% to 58%.
2. Already used at slaughter (C2): The ABMs were scored (from score 0 to 5) according to the answers received from the exercise of the NCPs Network (EFSA, 2023). Score 0 meant that the ABM was not reported to be assessed at slaughter; Score 1 that the ABM is assessed at slaughter in some countries but not for animal welfare monitoring; Score 2 meant that in most of the countries the ABM is assessed at slaughter but not for animal welfare monitoring; Score 3 meant that in some countries the ABM is assessed and used at slaughter to monitor animal welfare on farm; and Score 4 meant that in most of the countries is assessed and used the ABM at slaughter to monitor animal welfare on farm.
3. Priority given by the NCPs Network representatives (C3): The ABMs were scored according to the answers received from the EFSA scientific NCPs Network exercise (EFSA, 2023).
4. Technology readiness (C4): Each ABM was evaluated for the known level of readiness of an automated system to be adopted by the market, based on the technology readiness scale (Mankins, 1995). Score 0 meant none, Score 1 meaning basic principle or technology concept formulated, Score 2 meaning experimental proof of concept or validation, Score 3 meaning demonstrated technology on prototype in operational environment and Score 4 meaning system complete or proven in operational environment.

Lastly, weights were assigned by expert consensus to each criterion on its relative importance in addressing the mandate. The weights were as follow: C1 = 6; C2 = 1; C3 = 1; C4 = 2.

A final weighted score was calculated for each ABM following the formula below:

$$\text{Weighted score} = \frac{(\text{score}_{C1} * \text{weight}_{C1}) + (\text{score}_{C2} * \text{weight}_{C2}) + (\text{score}_{C3} * \text{weight}_{C3}) + (\text{score}_{C4} * \text{weight}_{C4})}{\sum_{C1}^{C4} \text{weights}}$$

The final selection was made through expert consensus and considering the requestor's requirement to identify a limited number of ABMs suitable for collection at slaughter.

The full process leading to the final list of ABMs that were selected is summarised in [Figure 8](#) (see [Section 3.3](#)).

In [Section 3.3](#), each selected ABM is described in detail, including its definition, interpretation, method of assessment, current use, possibilities for automation and the rationale for its selection. The justification was based on scientific evidence obtained through literature review (see [Appendix II](#) for details on the literature searches) and expert knowledge.

2.2.4 | Behavioural space model

A quantitative modelling approach was applied to calculate the minimum space that would allow farmed turkeys to express their behavioural repertoire. The model is based on the behavioural model to estimate space allowance requirements for laying hens (EFSA AHAW Panel, [2023b](#)). The model estimated the space required to perform six classes of behaviours, while accounting for the inter-individual distance between birds and the average percentage of birds performing these behaviours. The inter-individual distance is defined by the average of the minimum distance between two individual turkeys when expressing their behaviours. The behavioural classes reflect the differences in the occupied space when performing the behaviours and are illustrated in the upper part of [Figure 1](#).

The model uses the planimetric space required by turkeys in stationary behaviours (sitting, standing, resting, feeding and drinking) as a baseline. Planimetric space only refers to static spatial requirements (i.e. body space) and is the absolute minimum space required by a turkey to perform a certain behaviour (Ellerbrock & Knierim, [2002](#)). Four studies were identified that provided planimetric data for stationary behaviour in turkeys (Ellerbrock & Knierim, [2002](#); Graue et al., [2013](#); Kulke et al., [2017](#) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover; Spindler et al., [2016](#) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover). All studies were performed on individual birds in sitting or standing position using the colour contrast planimetric method and analysed using KobaPlan software. Age, body weight and average surface area occupied were extracted from the studies ([Annex A](#)). In cases where the body weight was not reported, body weights for the corresponding age were extracted from genotype-specific performance tables. A comparison with allometric scaling of the surface was used as additional evidence. Several expert knowledge elicitations (EKEs) to estimate the space needed to perform stationary behaviours were performed for different weight categories (7, 12, 16, 20 and 25 kg) representative of the EU production. This provided a range of weights and sizes of turkeys right before slaughter, when stocking density is expected to be at its maximum. The lower slaughter weights (7, 12 kg) are more typical for hens, 16 kg is used for toms and hens, and the higher slaughter weights (20, 25 kg) are more typical for toms.

Apart from planimetric space, turkeys' minimum space requirement also depends on the space needed to perform non-stationary behaviours and to organise themselves in social groups (Ellerbrock & Knierim, [2002](#)). Six behavioural classes were identified and modelled: (1) stationary behaviours (standing, resting, sitting, feeding and drinking), (2) dynamic behaviours (including only locomotion, foraging and exploration), (3) wing flapping, (4) dustbathing, (5) other comfort behaviours (i.e. preening and wing/leg stretching) and (6) strutting (only for turkey toms) ([Figure 1](#)). To estimate the requirements for non-stationary classes of behaviour, the baseline space requirement for stationary behaviour is multiplied by adjustment factors for each other class of behaviours. For this, the EFSA experts first agreed on schematic representations of the space the turkey would take up when performing (1) locomotion, (2) wing stretching, (3) wing flapping, (4) dustbathing and (5) strutting. Data on morphologic dimensions of turkeys (body width, body length, length of the tail, length of one wing, length from head to beak and length from neck to beak) ([Appendices A–C](#)) were collected within the EFSA experts' own network to support the calculation of the adjustment factors. Locomotory behaviour and wing stretching were chosen because these behaviours would require the most space in the behavioural classes of dynamic behaviour and other comfort behaviour, respectively. For each behaviour, the posture where turkeys extended to the greatest degree and took up the maximum space was considered. The adjustment factors for the occupied space were calculated using an elliptical model ([Figure 1](#)) of the total length and width of the animals performing the specific behaviours. It is assumed that the adjustment factors do not depend on body weight due to proportional growth, but may differ between hens and toms and thus were calculated separately for the two sexes. In total, the adjustment factors of classes of behaviours were estimated for all of the behavioural classes, except stationary behaviours. The details of the calculation are included in [Section 3.2.3](#).

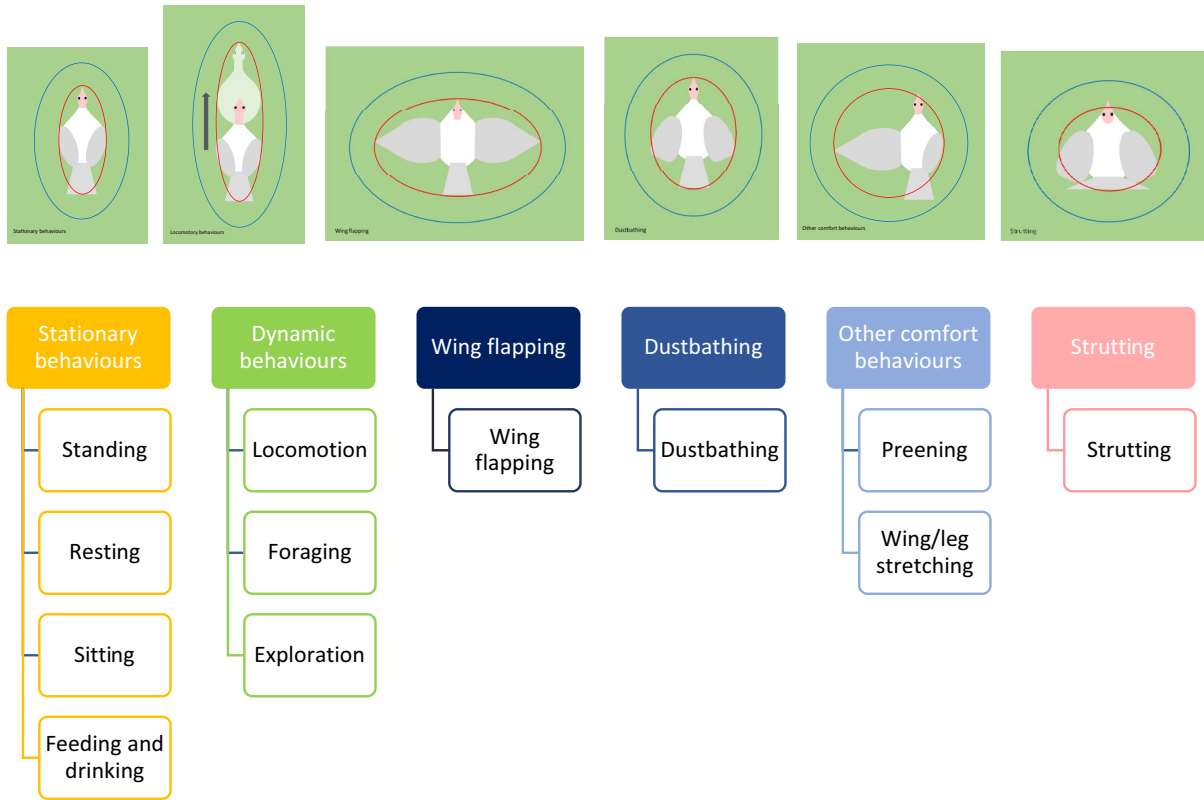


FIGURE 1 Classes of turkey behaviours accounted for in the behavioural space model according to a schematic representation of the occupied space. The red outline indicates the space occupied by the turkey expressing the behaviour, and the blue outline indicates the space occupied while taking into account the inter-individual distance between turkeys.

The classes of behaviour reflect major parts of a typical ethogram of the turkeys, presuming that allowing sufficient space for performing these behaviours enables the birds to achieve a higher welfare state by preventing certain welfare consequences (e.g. Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour). The space needed to perform each of the behaviours in the above classes, and available data on the proportion of birds performing these behaviours in a typical scan sampling situation in an unrestricted environment, were used to calculate minimum space requirements within a flock of turkeys.

2.2.4.1 | Outline of the behavioural space model for turkeys

For the estimation of the minimum space allowance of a flock the model was further simplified. To capture differently oriented birds, the necessary space per bird and class of behaviour is expressed by a circular shape, the position in a flock by close placing of circles (Figure 2) and the expression of different classes of behaviour by a weighted average (Equation 1).

The individual minimum space model is the weighted average of the total space A_c needed by one single turkey to perform a specific class of behaviour c , weighted by the proportion of birds P_c in the flock performing each of the behavioural classes. The proportion of birds performing dynamic behaviour, other comfort behaviours, wing flapping, dustbathing and strutting was elicited through EKEs. A_c (described in Equation 2), corresponds to the space taken by circles in close connection, namely the planimetric space needed for stationary behaviour a , the adjustment factor for other classes of behaviour (F_c), the inter-individual distance (D) and the additional space needed when placing circles next to each other.

$$S = \sum_{c=1}^6 A_c \cdot P_c \quad (1)$$

$$A_c = \omega \cdot \pi \cdot \left(\sqrt{\frac{a \cdot F_c}{\pi}} + \frac{D}{2} \right)^2 \quad (2)$$

with

- S Space allowance per turkey in a flock
- c Index of the six classes of behaviours
- P_c Proportion of birds in a flock performing the class of behaviour c
- A_c Minimum total space needed by a single turkey to perform the class of behaviour c

a	Planimetric surface occupied by a single turkey performing stationary behaviours
F_c	Adjustment factor to extrapolate from planimetric surface of stationary behaviour to the planimetric surface of behaviours of class c ($F_{\text{stationary}} = 1$)
D	Average inter-individual distance between two turkeys in a flock
w	Additional space, when putting circles close to each other (about +10%)

The minimum total space A_c (Equations 1 and 2) needed by one single turkey to perform a specific class of behaviour c consists of two parts: the planimetric space the turkey is occupying and the space around the turkey to hold a minimum inter-individual distance. For covering the planimetric space, a simple circular model is used, which allows the best use of the space by not considering additional space needed due to differently directed birds.

The model is representing the planimetric space $a_c = a \cdot F_c$ by a circle with the same area and a radius r_c (Equation 3):

$$r_c = \sqrt{\frac{a \cdot F_c}{\pi}} \quad (3)$$

and the total space $A_c = \pi \cdot R_c^2$ by an enlarged circle with radius R_c (Equation 4):

$$R_c = \left(r_c + \frac{D}{2} \right) \quad (4)$$

where D is the average inter-individual distance (Figure 2). This minimum inter-individual distance between birds performing the same class of behaviour is interpreted as an additional band around the circle with area $a_c = a \cdot F_c$ with a size of $D/2$ as described in Equation (4) and in Figure 2.

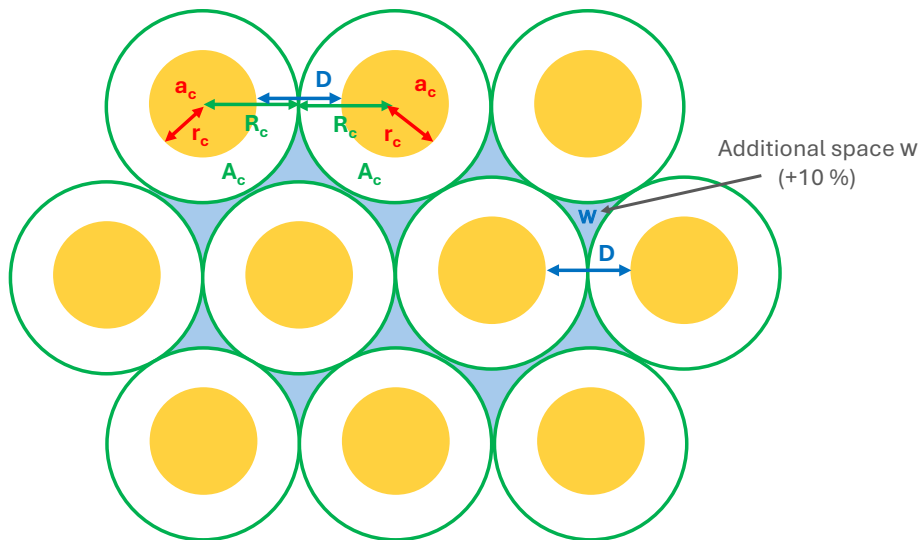


FIGURE 2 Schematic of a flock of turkeys. An individual colour filled circle represents the space occupied by a single turkey depicted as the planimetric space (a_c , the filled circles) plus the space accounting for the inter-individual distance (D) shown as open circles (A_c). This accounts all behavioural classes. The additional space w between the open circles represents the additional space needed when turkeys distribute themselves in a homogenous manner.

Maintaining inter-individual distance allows turkeys to organise themselves in social groups (Ellerbrock & Knierim, 2002) and is a way to create an area free of conspecifics around an individual as a social space requirement (Keeling, 1994). The distance is driven by the tension between avoidance of social conflict and maintenance of social cohesion, and depends, among others, on social hierarchy and the behaviour being performed (Buijs et al., 2011; Keeling, 1995). An appropriate inter-individual distance therefore also functions to reduce negative interactions and to promote positive behaviour and behavioural diversity (Keeling, 1994). The average inter-individual distance for all behaviours was elicited through separate EKEs for toms and hens due to differences in body size and behaviour (Section 3.2.3).

The model estimates the minimum space allowance as it assumes that the birds are distributed homogeneously (Figure 2), which occurs when there is a lack of space (Buijs et al., 2011), therefore the results may show a lower space allowance than what is really needed. A part of the space is not covered by circles. This area is called w and is about an additional 10% of the total space allowance. It is calculated with Equation (5) (Steinhaus, 2011).

$$w \cdot A = \left[1 + \frac{\sqrt{12} - \pi}{\pi} \right] \cdot A = \frac{A}{0.9069} \quad (5)$$

2.2.4.2 | *Space allowance based on the behavioural profile*

In order to estimate the minimum space required to express the behavioural repertoire of farmed turkeys, the space to perform each behaviour is multiplied by the average percentage of turkeys in a flock performing each behaviour at a specific time during daylight (P_c) (Equation 1) as some classes of behaviours require more space (i.e. dustbathing), but are conducted for a limited amount of time or by only a small percentage of the birds at the same time. The percentage of turkeys performing each behaviour was elicited through EKEs based on data extracted from studies and expert knowledge. To account for conditions which promote more non-stationary behaviour, the judgements for non-stationary behaviour represent the 75th percentiles of all the farming situations, while the percentage of stationary behaviour was calculated as the remaining part of the time budget.

Data were extracted from seven studies that reported behavioural time budgets of turkeys under different stocking densities (Beaulac & Schwan-Lardner, 2018; Busayi et al., 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU); Hammond et al., 2024a; Hughes & Grigor, 1996; Jhetam et al., 2022b; Sherwin & Kelland, 1998; Vermette et al. 2016b). Data were discussed and upon further scrutiny, Busayi et al. (2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU)), Hughes and Grigor (1996) and Sherwin and Kelland (1998) were excluded due to the methods of reporting results (e.g. not showing the needed interaction effects), use of genotypes not used anymore at the time of writing of this SO (2025) (e.g. B.U.T. 8) and use of pair housing. While specific data points from these three studies were not used, experts could use information from these papers to support their judgements. The remaining papers of Jhetam et al. (2022a, 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt), Beaulac and Schwan-Lardner (2018), Vermette et al. (2016a); Vermette et al. (2016b) and Hammond et al. (2024a); Hammond et al. (2024b) all originated from the same research group within North America using similar genotypes (Nicholas Select, Nicholas heavy strain) and methodology (4 studies, 33 data points).

Data extracted included information on sex, age, genotype, lighting programme and stocking density. In cases where stocking density was not reported, it was calculated based on genotype-specific target weights at the respective ages of the turkeys. Behaviours extracted included the proportion of time spent on stationary behaviours (standing, sitting, resting, drinking, feeding), dynamic behaviours (walking, foraging/exploratory behaviours), comfort behaviour (preening, dustbathing, wing and leg stretching, wing flapping), strutting in toms and other behaviour (Annex A). Not all studies reported the same behaviours, and such missing values were imputed with the median values of the studies which did report the respective behaviours. When the time budgets were reported for 24 h, a calculation to convert the time budget to the photophase was done. The final values were standardised to add up to 100 percent. The standardised proportions were plotted against the stocking density, age of the turkeys and expected body weight according to the growth curve to support discussions.

2.2.4.3 | *Expert knowledge elicitation for estimation of six parameters that feed into the behavioural space model*

The behavioural space model had as input parameters the planimetric space, the average minimum inter-individual distance and the percentage of time dedicated to the six classes of behaviour. As limited data were available in literature for turkeys, 13 EKEs were conducted to obtain the values that the parameters can take. The EKE protocol, including the evidence dossier, was prepared by EFSA staff and EFSA experts, and underwent several steps of review to include all the available evidence of interest for the EKE questions. A summary of the studies considered by the EFSA experts is presented in Section 3.2.3 *Space allowance* and as an annex in Excel. During the semi-formal EKEs (EFSA Scientific Committee, 2018), EFSA experts were asked to provide individual estimates for the lower and upper bounds (credible range), as well as the median and interquartile range for the parameter of interest. Each of these estimates was discussed by the EFSA experts, and a consensus was reached for each value. Then, a probability distribution per parameter was fitted to the elicited values and reviewed by the EFSA experts. To calculate the space allowance requirements for different weight categories of turkeys, these distributions went into a Monte-Carlo simulation with 10,000 iterations, which represent the uncertainty of the estimates. The median and 90% certainty intervals are reported as the result. The EKE questions and results are included in Appendix C.

2.2.4.4 | *Sensitivity analysis*

A sensitivity analysis was conducted to identify the input model parameters with the highest contributions to the overall uncertainty of the minimum space allowance per turkey. To do so, a linear regression was used to identify the relative contributions of each input parameter to the coefficient of determination R^2 of the minimum space allowance per turkey.

The minimum space allowance model assumes that each class of behaviour within a flock is displayed according to the percentage of time if it would occur under unrestricted conditions according to the time budget elicited through the EKEs (see Appendices C–L to R). This modelled minimum space allowance does not consider a synchronicity of the behaviour of the turkeys in a larger part of the flock. To address this, separate calculations were done for each class of behaviour to estimate the necessary space when 100% of the turkeys in the flock would perform the same class of behaviour at the same time.

2.2.5 | Uncertainty analysis

The uncertainty analysis followed the procedure described in the EFSA guidance on uncertainty analysis in scientific assessments (EFSA Scientific Committee, 2018) and EFSA guidance for the development of animal welfare mandates in the context of the Farm to Fork strategy (EFSA AHAW Panel, 2022b).

The uncertainty, related to conclusions in which limited evidence was found, was assessed through expert opinion. EFSA experts were asked to provide their individual judgement on the certainty for each of the selected conclusion according to three pre-defined certainty ranges (Table 3) (adapted from EFSA, 2019, Table 4). A group discussion during which experts had the opportunity to explain the rationale behind their judgement took place, and a consensus judgement on the range better reflecting the overall certainty was reached.

The uncertainty analysis related to the identification and description of current practices, the selection of the welfare consequences and their related ABMs was limited to the description of the potential sources of uncertainty, the nature or cause of the uncertainty and the potential impact of the uncertainty on the assessment.

TABLE 3 Certainty ranges used to express certainty around conclusion statements (adapted from EFSA, 2019).

Certainty range			
Quantitative assessment	> 50%–100%	66%–100%	90%–100%
Qualitative translation	More likely than not	From likely to almost certain	From very likely to almost certain

The main results of the uncertainty analysis are included in the Conclusions (Section 4) of this SO. Additional details on the uncertainty assessment process are presented in Appendix D, including the reasons for a lower certainty when the selected certainty category was > 50%–100%.

3 | ASSESSMENT

3.1 | Identification and description of the relevant welfare consequences (ToR B, Request 3) and related ABMs

Following the exercise described in Section 2.2, 19 out of the 26 welfare consequences were identified as relevant in view of the housing systems, hazards and practices considered in this mandate (see Section 2.2.2, Table 1 – the welfare consequences marked with an asterisk).

Other welfare consequences may negatively affect the welfare of turkeys, these were considered when assessing the specific hazards and practices listed in the mandate (see Section 3.2 addressing TOR B, Requests 2a-e). For example, when assessing the practice of artificial insemination (Section 3.2.12), the EFSA experts discussed also Bone lesions and Reproductive disorders. However, some other welfare consequences were evaluated of less relevance in terms of severity, duration and frequency of occurrence for the current mandate, and therefore not identified and are included in this Section. Relation to specific practices or hazards described in the assessment. These included Bone lesions (linked with semen collection in breeder toms Section 3.2.12), Reproductive disorders (associated with artificial insemination of breeder hens Section 3.2.12), Metabolic disorders and Skin disorders (Section 3.5 ABMs at slaughter). These are not further described in the following section.

The welfare consequences in this section are ordered alphabetically except for Cold and Heat stress which are described consecutively because they are influenced by the same factor, i.e. environmental effective temperature.

These 19 relevant welfare consequences and the related ABMs that can be used on farm to assess each of them are reported in Sections 3.1.1–3.1.19. Firstly the welfare consequences is defined, then a definition, a brief description and an interpretation of the ABMs in relation to the specific welfare consequence are also provided. As specified in the Interpretation of ToRs (Section 1.2) the ABMs included because they were found in the literature search and also considered in the assessment of the hazards of this mandate.

Due to a scarcity of ABM definitions specifically for turkeys, the EFSA experts reviewed the applicability of ABM definitions from other SOs, including those on the welfare of broilers (EFSA AHAW Panel, 2023a), laying hens (EFSA AHAW Panel, 2023b) and ducks, geese and quail (EFSA AHAW Panel, 2023c). When necessary, these definitions were adapted to suit turkeys. In such cases, ABMs have been identified with the relevant information in brackets, e.g. ‘(adapted from EFSA AHAW Panel, 2023a)’.

As explained in the Interpretation of the ToRs (Section 1.2), in this SO each ABM is described in relation to its primary welfare consequence, to which it has a direct link. However, it will be indicated if the ABM could have an indirect link also to other welfare consequences.

3.1.1 | Cold stress

3.1.1.1 | Description

The animal experiences stress and/or negative affective states, such as discomfort and/or distress, when exposed to too low effective environmental temperature (EFSA AHAW Panel, [2022a](#)) (see also Section [3.2.6](#)). In turkeys, this welfare consequence is experienced mainly by poults or by other turkey categories when housed in some outdoor range systems.

3.1.1.2 | Animal-based measures

The ABMs to measure Cold stress are **huddling** and **cloacal temperature**.

Huddling:

- **Definition and description:** Turkeys group together in small or larger groups and/or sometimes climb on top of each other, sitting often in clumps, which is distinct from normal loose grouping that turkeys show when resting in the absence of Cold stress (Berk, [2024a](#); Mailyan & van Schie, [2019](#)). Huddling reduces or prevents heat loss.

A particularly critical period occurs after the poults have been transported from the hatchery to the barn, especially in cold temperatures. If the temperature is right, poults can spread out evenly or flock together in small groups of about 20–30 birds (Mailyan & van Schie, [2019](#)). Piling up or gathering in a corner following a fearful stimulation is not huddling (EFSA AHAW Panel, [2023a](#)).

- **Interpretation:** The proportion of turkeys showing huddling in the flock can be used as an indicator for Cold stress (Welfare Quality®, [2009](#)). However, huddling poults do not always indicate that poults are cold, but it can also be caused by high concentrations of CO₂ (Bugueno, [2024](#)).

Cloacal temperature:

- **Definition and description:** Core body temperature is estimated by the proxy cloacal temperature of the turkey, which is more accurate than measuring temperature with an infrared ear thermometer (Mailyan & van Schie, [2019](#)).

The average body temperature of a turkey is about 41°C (Brown-Brandl et al., [1997a](#); Wilson & Woodard, [1955](#)), whereas the normal body temperature for a poult is 39.4°C–40°C (Bugueno, [2024](#); Mailyan & van Schie, [2019](#)).

Interpretation: A core body temperature lower than the normal temperature indicates that poults are too cold.

3.1.2 | Heat stress

3.1.2.1 | Description

The animal experiences stress and/or negative affective states such as discomfort and/or distress when exposed to too high effective environmental temperature, i.e. above the thermal comfort zone (EFSA AHAW Panel, [2022a](#)) (see also Section [3.2.6](#)).

3.1.2.2 | Animal-based measures

The ABMs to measure Heat stress are **panting**, **wings held away from the body** and **cloacal temperature**.

Panting:

- **Definition and description:** Breathing with short, quick breaths with an open beak (adapted from Welfare Quality®, [2009](#)). When a turkey is panting, it actively increases heat dissipation via the respiratory route.
- **Interpretation:** The higher the proportion of turkeys panting in the flock or the more severe the panting is, the more Heat stress experienced (adapted from EFSA AHAW Panel, [2023a](#)).

Wings held away from the body:

- **Definition and description:** Turkeys exhibit spreading and dropping of wings to increase convective heat dissipation and radiate heat from areas of the body with little feathering and high blood circulation, causing a decrease to their core temperature (adapted from EFSA AHAW Panel, [2023a](#); Veldkamp, [2002](#)). When turkeys hold their wings away from the body, the surface exposed to the air flow is increased.

- **Interpretation:** The higher the proportion of turkeys in a flock showing wings held away from the body indicates increased Heat stress.

Cloacal temperature:

- **Definition and description:** see Section 3.1.1 Cold stress.
- **Interpretation:** A core body temperature higher than the ideal temperature indicates that the turkey is experiencing Heat stress.

3.1.3 | Eye disorders

3.1.3.1 | Description

The animal experiences negative affective states such as discomfort, pain and/or distress due to irritation or lesion or lack of function of at least one eye (EFSA AHAW Panel, 2022b).

3.1.3.2 | Animal-based measures

The ABMs to measure Eye disorders in turkeys are **eye development abnormalities** and **eye pathologies**.

Eye development abnormalities:

- **Definition and description:** Eye abnormalities include developmental anomalies described in turkey poults such as bu-phthalmos (enlargement of the eyeball) (Ashton et al., 1973), cataracts (French, 1994; Keymer, 1977) and optic nerve hypoplasia (Barr et al., 1988). In chicks (*Gallus gallus domesticus*), ocular albinism (Rymer et al., 2007), glaucoma (Shivaprasad & Gelatt, 1999), microphthalmia, which is characterised by one or two abnormally small eyes (Ehrlich et al., 1989), blindness (Ehrlich et al., 1989), cyclopia, three eyes, anophthalmia (absence of one or both eyes) have been reported. They can result from genetic anomalies (Shivaprasad & Korbel, 2003), but in most cases they are caused by suboptimal incubation conditions (French, 1994; Shivaprasad & Gelatt, 1999). described in turkey poults sfrom,
- **Interpretation:** Eye disorders are indicated by the presence of eye development abnormalities, including those described above. A greater number of turkeys with eye development abnormalities in a flock indicates Eye disorders which may be caused by genetical anomalies or suboptimal incubation conditions.

Eye pathologies:

- **Definition and description:** Eye pathologies encompass infectious and non-infectious diseases, degenerative processes, tumours, injuries and pathological conditions of unknown origin (Koncicki et al., 2025). Respiratory infectious diseases often lead to eye pathologies in poultry and manifest with conjunctivitis, resulting in foamy eye discharge from the conjunctival sac (Cheville et al., 1988).
- **Interpretation:** Eye disorders are indicated by the presence of eye pathologies, including those described. Respiratory disorders caused by infectious agents lead to conjunctivitis (Cheville et al., 1988). Prolonged light exposure leads to blindness (Davis & Siopes, 1985) and cataracts (Leis et al., 2017).

3.1.4 | Gastroenteric disorders

3.1.4.1 | Description

The animal experiences negative affective states such as discomfort, pain and/or distress due to impaired function of the gastrointestinal tract resulting from, for example, nutritional deficiency and infectious, parasitic or toxigenic agents (EFSA AHAW Panel, 2023a).

3.1.4.2 | Animal-based measures

The ABMs to measure Gastroenteric disorders in turkeys are **soiled cloacal area** and **feather and body dirtiness**.

Soiled cloacal area:

- **Definition and description:** Diarrhoeic faeces that soil the area of the cloaca.
- **Interpretation:** Gastroenteric disorders are indicated by the presence of birds with diarrhoea.

Feather and body dirtiness:

- **Definition and description:** Degree of dirtiness of the feather and body (particularly the ventral part) due to it being wet or soiled with litter, faeces or dirt (adapted from Welfare Quality®, 2009).

Turkeys with gastroenteric disorders have wet faeces that will make the cloaca dirty and degrade the litter that will stick to both to the turkeys with Gastroenteric disorders and to other turkeys.

- **Interpretation:** Gastroenteric disorders will result in feather and body dirtiness due to soiling with faeces.

Feather and body dirtiness may also have other causes, e.g. water spillage causing wet litter or droppings from birds on elevated structures falling on conspecifics below.

Pendulous crop:

- **Definition and description:** the crop distends down from its normal position and prevents the movement of feed and water from the crop down into the digestive system (Abdalla et al., 2022).
- **Interpretation:** Gastroenteric disorders are indicated by the presence of turkeys with pendulous crop.

3.1.5 | Group stress

3.1.5.1 | *Description*

The animal experiences stress and/or negative affective states such as pain, fear and/or frustration resulting from a high incidence of aggressive and other types of negative social interactions, often due to competition for resources (adapted from EFSA AHAW Panel, 2023a). Group stress in turkeys kept under commercial conditions can occur during hierarchy formation, this is not commonly because they are kept in large groups that are too big to establish such as where hierarchy formation does not take place.

Due to the inadequate availability of resources, Group stress could be the result of other welfare consequences as secondary welfare consequences like inability to perform exploratory or foraging behaviour, Restriction of movement, Resting problems and inability to perform comfort behaviour.

Turkeys subjected to Group stress can experience secondary welfare consequences as result of negative interactions within the group, in particular Soft tissue lesions and integument damage.

3.1.5.2 | *Animal-based measures*

The ABMs to measure Group stress are (i) **injurious pecking** (severe feather pecking, cannibalism, aggressive pecking), (ii) **agonistic interactions other than pecking** and (iii) **bird-to-bird disturbance**.

Injurious pecking:

- **Definition and description:** Injurious pecking includes severe feather pecking, cannibalism and aggressive pecking, the latter targeting mainly the head area (Dalton et al., 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). Injurious pecking consists of pecking conspecifics at the feathers, skin or tissue, resulting in plumage or tissue damage and bleeding.

Severe feather pecking occurs when one bird pecks or pulls at the feathers of a conspecific. In cases where persistent cannibalistic pecking occurs, the pecking may, in addition to tissue damage and open wounds, lead to mortality. It has been suggested that it is more prevalent in larger groups (Allen & Perry, 1975; Lindberg, 1994).

- **Interpretation:** Group stress is indicated by injurious pecking. There may be at least two pathways leading to the development of feather pecking: (1) it may be caused by inability to perform exploratory or foraging behaviour, i.e. severe feather pecking is then a form of redirected exploratory or foraging behaviour. In this case, Group stress is not the cause, but it may be the consequence of severe feather pecking due to the discomfort inflicted; (2) Group stress may also be the direct cause (trigger) of severe feather pecking, as also described for laying hens (De Haas et al., 2021). A higher level of injurious pecking indicates more Group stress.

Agonistic interactions other than pecking:

- **Definition and description:** Interaction between birds including threats, chases and fights including leaping, ranked according to severity (Buchwalder & Huber-Eicher, 2003). According to Buchwalder and Huber-Eicher (2003), such

behaviours are a natural component of turkey social dynamics but can escalate under certain environmental or management conditions. Threats typically involve visual displays, such as feather ruffling, head movements or vocalisations used to assert dominance and avoid physical conflict. Chasing occurs when a dominant bird forces a subordinate to retreat. Fights including leaping are in the more severe end of the scale and involve physical contact such as wing beating, kicking or grappling and can result in injuries.

- **Interpretation:** Group stress is indicated by agonistic interactions other than pecking.

Bird-to-bird disturbance:

- **Definition and description:** A bird makes physical contact with another bird thereby forcing the latter to change its original position or behaviour (EFSA AHAW Panel, 2023a). In turkeys, response to disturbance is described as a bird resting that opens the eyes, lifts the head or moves other body parts including standing up as a result of another bird walking in front of it, on top of it, touching or wing flapping near the resting bird (Beaulac & Schwan-Lardner, 2018).

Frequent bird-to-bird disturbances can lead to increased restlessness, reduced sleep quality and elevated stress levels, ultimately impacting growth, immune function and overall welfare (Forslund et al., 2021).

- **Interpretation:** While bird-to-bird disturbance is expected to occur in group housing systems, excessive disturbances indicate Group stress.

3.1.6 | Handling stress

3.1.6.1 | Description

The animal experiences stress and/or negative affective states such as pain and/or fear resulting from human or mechanical handling (e.g. sorting and vaccination of newly-hatched poults, handling during semen collection/artificial insemination of breeder turkeys) (adapted from EFSA AHAW Panel, 2022a).

In terms of hatchery procedures applied to poults (i.e. poult servicing), practices such as sorting, vaccinating and procedures (e.g. beak trimming, toe trimming, desnooding) require some degree of human or mechanical handling (Grimes & Pardue, 1996). The scientific literature on the handling of turkey poults at hatcheries is sparse (Schwan-Lardner, 2018) and EFSA experts therefore mainly relied on literature from broilers and layers.

Turkeys kept for meat production or breeding are also handled when being moved between barns, during data collection in breeding flocks, during semen collection from toms and insemination of hens in breeding flocks (Erasmus, 2017; Jong & Swalander, 2012; Schwartzkopf-Genswein et al., 2012). Handling stress could result in other welfare consequences such as Soft tissues lesions and integument damage, as well as Bone lesions (see Section 3.2.12) and Reproductive disorders (see Section 3.2.12). There are few studies on the effects of handling in turkeys. In day-to-day operations, handling likely does not occur often (with the above-mentioned exceptions).

3.1.6.2 | Animal-based measures

The ABMs to measure Handling stress are **poult righting time, proportion of poults falling on the floor, escape attempts** and **resistance to handling**.

Poult righting time:

- **Definition and description:** The time taken for a poult to regain normal sitting or standing posture when placed on the back (adapted from broilers, EFSA AHAW Panel, 2023a).

Poult disorientation may occur due to the processes in the hatchery (e.g. speed of the conveyor belts, drops).

- **Interpretation:** The time a poult takes to right itself reflects Handling stress, i.e. the longer the righting time, the more severe the handling stress experienced by the poult (adapted from broilers, EFSA AHAW Panel, 2023a).

Proportion of poults falling on the floor:

- **Definition and description:** Proportion of poults falling on the floor during the hatchery procedures (adapted from broilers, EFSA AHAW Panel, 2023a).
- **Interpretation:** Poults may fall on the floor during manual or mechanical handling. The higher the occurrence of poults falling on the floor, the more poults experience Handling stress (adapted from broilers, EFSA AHAW Panel, 2023a).

Escape attempts:

- Definition and description: Attempts to move, run or fly away from a human approaching the bird (Erasmus & Swanson, 2014).
- Interpretation: Escape attempts when approaching indicate that Handling stress is experienced by the turkeys due to the actions of the human being perceived as a fear-inducing stimulus.

Resistance to handling:

- Definition and description: Moving, running or flying away or attempts to do so (i.e. struggling), often accompanied by vocalisations, when handled, i.e. when caught/restrained by a human (adapted from broilers, EFSA AHAW Panel, 2023a). Noonan (1999) proposed a rating system for struggling in turkeys where feet, upper body and wings could be used.
- Interpretation: Handling stress is indicated by behavioural indicators of resistance performed by the handled and restrained bird.

3.1.7 | Inability to express pre-laying and nesting (maternal) behaviour**3.1.7.1 | Description**

The breeder hen experiences stress and/or negative affective states such as frustration resulting from the thwarting of the motivation to lay eggs in a nest and incubate them (adapted from EFSA AHAW Panel, 2023a).

The Inability to express nesting (maternal) behaviour is influenced by the possibility to lay eggs in a nest that is adequate for turkey hens (see also Section 3.2.10).

3.1.7.2 | Animal-based measures

The ABMs to measure Inability to express pre-laying and nesting (maternal) behaviour are **proportion of eggs outside the nest, interrupted nesting behaviour and attempts at nesting behaviour**.

Proportion of eggs outside the nest:

- Definition and description: Number of eggs laid outside the nest out of the total number of eggs produced (EFSA AHAW Panel, 2023c). The presence of eggs outside the nest (on the floor) may result from a mismatch between the nest requirements and preferences of the turkey hens and what is offered to them. When the nests are not accessible or do not fulfil the birds' preferences, it is likely that hens will choose to lay their eggs on the litter.
- Interpretation: Inability to express pre-laying and nesting (maternal) behaviour is indicated by a high proportion of eggs laid outside the nests. A high proportion of eggs outside the nests is expected during the first few weeks of laying until the hens learn how to use the nests.

Interrupted nesting behaviour

- Definition and description: Interrupted nesting behaviour takes place when hens are forced to leave the nests, thus reducing the duration of nesting/brooding. Up to 20%–30% of the turkey hens show broodiness at least once in their lifespan (Brière et al., 2010).
- Interpretation: Interrupting nesting behaviour will lead to frustration due to the Inability to express nesting (maternal) behaviour. Broodiness per se is not a welfare issue: it is a natural behaviour of turkey hens to sit on a clutch of eggs and incubate them.

Attempts at nesting behaviour

- Definition and description: The number of attempts to visit the nest by a hen.
- Interpretation: Unsuccessful attempts to enter a nest to perform nesting behaviour (e.g. because the nest is occupied or inaccessible) lead to frustration and indicate Inability to express pre-laying and nesting behaviour.

3.1.8 | Inability to perform comfort behaviour**3.1.8.1 | Description**

The animal experiences stress and/or negative affective states such as discomfort and/or frustration resulting from the thwarting of the motivation to maintain the function and integrity of the integument (e.g. when cannot keep it clean, perform scratching and dustbathing) (adapted from EFSA AHAW Panel, 2022b).

Due to the availability of limited space allowance,

Inability to perform comfort behaviour could be the result of another welfare consequence, such as Restriction like Restriction of movement. For more information, see Section 3.2.3.

3.1.8.2 | *Animal-based measures*

The ABMs to measure Inability to perform comfort behaviour are **preening**, **wing and leg stretching**, **wing flapping**, **dustbathing** and **feather and body dirtiness**.

Preening:

- **Definition and description:** Involves raising the feathers to clean and realigning them with the beak. The turkey, while standing or sitting (Hammond et al., 2024), directs the beak to its own plumage on any of its body parts and carries out pecking, nibbling, combing or rotating movements, once or repeatedly (EFSA AHAW Panel, 2023a; adapted from Zhao et al., 2014). During the process, lubrication from the preen gland at the base of the tail is distributed to the feathers. Preening behaviour is essential to maintain the plumage in good condition.

Turkeys preen more when the light intensity (Barber et al., 2004) and space allowance are higher (Bessei & Günther, 2005; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt).

An association between feather lipid levels and availability/quality of substrate for dustbathing has been found, which is likely to influence the prevalence of preening in *Gallus gallus domesticus* (Sandilands et al., 2004).

- **Interpretation:** Inability to perform comfort behaviour is indicated by reduced preening. However, if birds cannot perform other comfort behaviours, they may perform preening as a displacement behaviour (Duncan & Wood-Gush, 1972).

Wing and leg stretching:

- **Definition and description:** The turkey carries out unilateral backward and downward stretch of the wing and leg together (adapted from EFSA AHAW Panel, 2023b). Wing and leg stretching is a comfort behaviour essential for maintenance of muscles and joints (Fraser, 1989).
- **Interpretation:** Inability to perform comfort behaviour is indicated by reduced wing and leg stretching (EFSA AHAW Panel, 2023c).

Wing flapping:

- **Definition and description:** Bilateral rapid upward and downward movement of the wings performed while standing still (Sokołowicz et al., 2020). Wing flapping is categorised as a comfort behaviour when it is performed after dustbathing or preening to get the dirt/feather debris off the feathers and rearrange the feathers. It is also considered a comfort behaviour if done from a standing position with maximum a few steps being taken, likely with the purpose of stretching muscles and joints.
- **Interpretation:** Inability to perform comfort behaviour is indicated by a reduced frequency of wing flapping.

However, wing flapping can have different meanings depending on the context. Wing flapping may also be performed in the context of aggression or when the bird is in a state of alertness (Bartels et al., 2020). Furthermore, in young turkeys, wing flapping may be an element performed during play behaviour.

Dustbathing:

- **Definition and description:** A sequence of movements that starts with a turkey lying down and tossing loose material onto and between the feathers. Other activities may occur in variable sequences during a dustbathing bout, including side lying, scratching, beak raking, head and body rubbing. A dustbathing bout usually ends with body shaking, which removes dust from the plumage (adapted from EFSA AHAW Panel, 2023a; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt) and wing flapping. Dustbathing is important for turkeys to keep their plumage in good condition.
- **Interpretation:** A high proportion of interrupted dustbathing sessions, where a turkey starts but does not complete the sequence, suggests conditions like inadequate or missing substrate (Larsen et al., 2000), insufficient space or lack of physical or social protection (Louton et al., 2016). Inability to perform comfort behaviour is indicated by reduced dustbathing. Reduced prevalence of dustbathing can indicate Inability to perform comfort behaviour (adapted from EFSA AHAW Panel, 2023a). Furthermore, the study by Jhetam et al. (2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt) found no correlation between stocking density and the prevalence of dustbathing (among other comfort behaviours), at 11 weeks of age.

Feather and body dirtiness:

- Definition and description: See Section 3.1.4.2 Gastroenteric disorders.

Normally, birds keep their feathers and skin clean to keep warm and to protect themselves against dirt and skin infections. If feathers become wet or soiled with litter, faeces or dirt, the plumage loses its functional role, which will result in negatively affective states due to the discomfort and/or frustration resulting from the inability to keep clean (EFSA AHAW Panel, 2023a).

- Interpretation: Inability to perform comfort behaviour is indicated by increased feather and body dirtiness.

3.1.9 | Inability to perform exploratory or foraging behaviour

3.1.9.1 | *Description*

The animal experiences stress and/or negative affective states such as frustration and/or boredom resulting from the thwarting of the motivation to investigate the environment or to seek for food (i.e. extrinsically and intrinsically motivated exploration) (EFSA AHAW Panel, 2022b).

3.1.9.2 | *Animal-based measures*

The ABMs to measure Inability to perform exploratory or foraging behaviour include **pecking** (Dalton et al., 2018) and **injurious pecking**. The ABMs to measure Inability to perform exploratory and foraging behaviour include **pecking** (Dalton et al., 2018) and **injurious pecking**.

Pecking:

- Definition and description: The turkey pecks at particles on the ground. Pecking may be performed in a sequence with walking while searching for available materials in the environment (e.g. litter, housing elements, walls, enrichment material), or, more infrequently, by scratching the ground with one or two feet (Dalton et al., 2018).
- Interpretation: Inability to perform exploratory or foraging behaviour is indicated by reduction in the proportion of birds in the flock and in the time spent pecking (adapted from EFSA AHAW Panel, 2023c).

Injurious pecking:

- Definition and description: Injurious pecking is a form of redirected exploratory or foraging behaviour (see also definition in Section 3.1.5.1 Group stress).
- Interpretation: Injurious pecking increases with Inability to perform exploratory or foraging behaviour. Injurious pecking is an ABM that can also be used to assess Group stress (see Section 3.1.5).

3.1.10 | Locomotory disorders (including lameness)

3.1.10.1 | *Description*

The animal experiences negative affective states such as pain or discomfort due to impaired locomotory behaviour induced by e.g. bone, joint, skin, muscle or nail damage (adapted from EFSA AHAW Panel, 2022b).

When turkeys experience Locomotory disorders (including lameness), this may influence their ability to perform other behaviours (adapted from the broilers SO, EFSA AHAW Panel, 2023a), for example reaching the feeder and the drinker.

3.1.10.2 | *Animal-based measures*

The ABMs to measure Locomotory disorders (including lameness) are **walking ability/gait score** and **leg deformation**.

Walking ability/gait score:

- Definition and description: Walking ability/gait score is the extent to which the turkey is able to walk, varying from unaffected gait to slight changes in gait to obvious lameness or even lack of mobility (Kapell et al., 2017; Marchewka et al., 2015; Quinton et al., 2011). This ABM is typically a subjective assessment that includes a range of attributes, such as posture and motion. Various skeletal disorders (leg deformations) can impact the legs of turkeys and thus their walking ability (Erasmus, 2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming

Brussels (CIWF EU)). Differences in gait and/or bone characteristics have been observed between wild and domesticated turkeys (Stover et al., 2018), between different genetic lines of turkeys (Oviedo-Rondón et al., 2017) and between turkeys with different leg disorders (Oviedo-Rondón et al., 2018).

- **Interpretation:** The higher the prevalence of poor **walking ability/gait score** in a flock, the higher the prevalence of turkeys experiencing Locomotory disorders (including lameness). Locomotory disorders are indicated by poor walking ability/gait score.

Leg deformation:

- **Definition and description:** Abnormality of the growth cartilage that results in deformed bones and, at least in severe cases, causes walking impairment. These may include long bone distortion such as varus and valgus deformities (also referred to as hocks-in/feet-out, knock-kneed legs, hockey stick legs, X legs, hocks-out/feet-in, bowlegged, cowboy legs, O legs) and rotated tibia, shaky leg, tibial dyschondroplasia and crooked toes (Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU); Kapell et al., 2017).
- **Interpretation:** The higher the proportion of turkeys with leg deformation in a flock, the more turkeys experience Locomotory disorders (including lameness) (adapted from EFSA AHAW Panel, 2023c).

3.1.11 | Predation stress

3.1.11.1 | Description

The animal experiences stress and/or negative affective states such as fear and/or pain resulting from being attacked or perceiving a high predation risk (EFSA AHAW Panel, 2022b).

3.1.11.2 | Animal-based measures

The ABMs to measure Predation stress are **mortality due to predation** and **excess missing birds above the recorded mortality**.

Mortality due to predation:

- **Definition and description:** Number of birds found dead, killed or needing to be culled after severe injury by a predator, divided by the total number of birds present in the period considered (adapted from EFSA AHAW Panel, 2023a). When birds are scared, they might try to run away, and when they are indoors, they might pile up, typically in a corner of the house, with some birds dying from suffocation or stress. Birds found dead from a piling event may have been scared by a predator or what they had perceived as a predator or a threat, but the frightening stimulus leading to piling is not specific to predation (EFSA AHAW Panel, 2023a).
- **Interpretation:** Predation stress is indicated by birds found dead with evidence of bites or part of the body eaten or missing birds.

Missing birds above the recorded mortality:

- **Definition and description:** Any turkeys whose death goes unaccounted for in the records (adapted from EFSA AHAW Panel, 2023b). Especially when turkeys have access to outdoor areas, it can happen that aerial or terrestrial predators may consume or take the turkey with them entirely (in case of a young, small-sized animal).
- **Interpretation:** Missing turkeys housed outdoors can be considered an indicator for Predation stress (EFSA AHAW Panel, 2023b).

3.1.12 | Prolonged thirst

3.1.12.1 | Description

The animal experiences craving or urgent need for water, accompanied by a negative affective state and eventually leading to dehydration, as metabolic requirements are not met (EFSA AHAW Panel, 2022b).

3.1.12.2 | Animal-based measures

The ABMs to measure Prolonged thirst in turkeys are **small size (runts)** and **first week mortality**.

Small size (runts):

- Definition and description: see Section 3.1.12.2 Prolonged hunger.
- Interpretation: An increased proportion of runts reflects poor hydration and is associated with Prolonged thirst.

First week mortality rate:

- Definition, description and Interpretation: see Section 3.1.12.2 Prolonged hunger.

3.1.13 | Respiratory disorders

3.1.13.1 | Description

The animal experiences negative affective states such as discomfort, pain, air hunger and/or distress due to impaired function or lesions of the respiratory system (adapted from EFSA AHAW Panel, 2022b).

3.1.13.2 | Animal-based measures

The ABM to measure Respiratory disorders is **head shaking**.

Head shaking:

- Definition and description: The turkey moves the head away from the sagittal line and swings it rapidly to the left or right (adapted from Liu et al., 2021).

This behaviour indicates aversion towards inhaling toxic components such as ammonia and attempts is used to clear excessive bronchial secretions (Andrani et al., 2019). Liu et al. (2021) showed that head shaking in broilers positively correlates with increased ammonia concentration, indicating irritation of the airways.

- Interpretation: Respiratory disorders are indicated by turkeys showing head shaking.

3.1.14 | Prolonged hunger

3.1.14.1 | Description

The animal experiences craving or urgent need for feed or a specific nutrient, accompanied by a negative affective state, possibly leading to a weakened condition, as metabolic requirements are not met (adapted from EFSA AHAW Panel, 2022b).

3.1.14.2 | Animal-based measures

There is no a direct measure for Prolonged hunger. Indirect ABMs to measure Prolonged hunger are **small size (runts)**, **object pecking** and **first-week mortality**.

Small size (runts):

- Definition and description: The turkey or the poult is visibly smaller than the average of the flock, approximately half the size of an average turkey or poult in the flock (adapted from AWIN, 2015).

There are several factors causing small size in poults and turkeys kept for meat production or breeding, such as inappropriate nutrition and water consumption (adapted from AWIN, 2015). If some very small turkeys or poults (runts) are present in a flock, they will not be able to reach the feeders and drinkers, which are periodically raised to align with the growth of most turkeys in the flock. As a result, the runts experience 'Prolonged hunger' and 'Prolonged thirst'.

- Interpretation: An increased proportion of runts reflects poor nutrition and is associated with prolonged hunger.

Object pecking:

- Definition: The turkey pecks at inedible objects in an invariant way, e.g. at spots on the wall (called spot pecking), the empty feed trough or other structures, in a stereotypic way (Hocking, 1999; Savory et al., 1992).
- Interpretation: An increased proportion of turkeys performing object pecking is associated with Prolonged hunger.

First-week mortality rate:

- **Definition:** The sum of the number of poults found dead and culled during the first week while kept on farm, in relation to the total number of poults placed.
- **Interpretation:** High first-week mortality rate may indicate Prolonged thirst and/or Prolonged hunger of the poults. However, a high first-week mortality rate may also indicate other problems (e.g. diseases, predation, etc.).

3.1.15 | Resting problems

3.1.15.1 | Description

The animal experiences stress and/or negative affective states such as discomfort, fatigue and/or frustration due to the inability to lie, rest comfortably or sleep (e.g. due to wet litter, absence of perches) (adapted from EFSA AHAW Panel, 2022b).

3.1.15.2 | Animal-based measures

The ABMs to measure Resting problems are the **proportion of birds resting on elevated structures** and **bird-to-bird disturbance**.

Proportion of birds resting on elevated structures:

- **Definition and description:** While resting on an elevated structure (e.g. a platform or perch) birds do not move, and resting can be performed in a sitting or a standing position. The head is either tucked backwards into the feathers above the wing base or behind a wing, or in a forward position and may hang down (Berk, 2014; Berk & Cottin, 2008; Marks, 2017; Toppel et al., 2016). Both eyes or one eye are either closed or slowly opened and closed (Ayala-Guerrero et al., 2003; adapted from EFSA AHAW Panel, 2023a; Mascetti & Vallortigara, 2001).

Turkeys are motivated to use elevated structures to rest, especially at night. The use depends on whether the elevated structures are easily accessible, for example via ramps. However, this depends also on the time of first experience with elevated structures, the period of day and the age of the birds.

- **Interpretation:** A lower proportion of turkeys resting on an accessible elevated platform indicates Resting problems.

Bird-to-bird disturbance:

- **Definition and description:** see Section 3.1.3.2 Group stress.
- **Interpretation:** While bird-to-bird disturbance is expected to occur in group housing systems, excessive disturbances indicate Resting problems.

3.1.16 | Restriction of movement

3.1.16.1 | Description

The animal experiences stress and/or negative affective states such as pain, fear, discomfort and/or frustration due to the fact that it is unable to move freely or move parts of the body when in a static position, or is unable to walk comfortably (e.g. due to overcrowding, unsuitable floors, gates, barriers) (adapted from EFSA AHAW Panel, 2022b).

3.1.16.2 | Animal-based measures

The ABMs to measure Restriction of movement in turkeys are **locomotory behaviour**, **wing flapping** and **strutting** (see also Section 3.2.3).

Locomotory behaviour:

- **Definition and description:** The turkey moves from one place to another using leg and/or wing-assisted movements that result in walking, running, jumping and flying activities (adapted from EFSA AHAW Panel, 2023a).
- **Interpretation:** Restriction of movement is indicated by less locomotory behaviour observed. It should be noted that as turkeys become heavier or are affected by issues such as locomotory disorders or footpad dermatitis, they may also show a reduced walking ability (for more details see Section 3.1.9 Locomotory disorders (including lameness)).

Wing flapping:

- Definition and description: see Section 3.1.7.2 Inability to perform comfort behaviour.
- Interpretation: A lower frequency of wing flapping may indicate that the bird experiences restriction of movement.

Strutting:

- Definition and description: The turkey tom walks slowly, fans its tail feathers, droops the wings and erects all body feathers. The head is bent over the back in an S shape, and the breast thrust forward (Sherwin & Kelland, 1998).

Strutting is a behaviour that can occur during courtship, inter-male threats or threats by potential predators (reviewed by Sherwin & Kelland, 1998). Strutting requires a large amount of space to be performed. This behaviour starts between 3 and 4 weeks of age and increased with sexual maturity.

- Interpretation: Restriction of movement of turkey toms can hamper strutting. However, interpretation of this ABM should ideally be placed in context based on the motivational background of the turkey toms.

3.1.17 | Sensory under- and/or overstimulation

3.1.17.1 | Description

The animal experiences stress and/or negative affective states such as fear and/or discomfort due to visual, auditory or olfactory under-/overstimulation by the physical environment (EFSA AHAW Panel, 2022b).

Turkeys rely heavily on sensory cues from their physical (e.g. visual, auditory or olfactory) and social environment to maintain homeostasis and express species-specific behaviours (Marchewka et al., 2013). The environment may either fail to provide sufficient stimulation (understimulation) or deliver excessive or abrupt stimulation (overstimulation) (EFSA AHAW Panel, 2022b).

Understimulation can occur in the hatchery, where eggs are often kept in prolonged darkness with limited environmental variation (see Section 3.2.11 Lighting conditions and Section 3.2.14 on hatchery conditions).

Overstimulation can occur both suddenly and chronically. Sudden overstimulation involves acute, unpredictable events, such as sudden loud noises (e.g. machinery, workers), abrupt light changes (e.g. switching on bright lights in a dark barn) or sudden drafts or temperature shifts (see Section 3.2.6). These events can startle turkeys, eliciting fear responses and panic. Chronic overstimulation may occur with persistently high noise levels (e.g. mechanical ventilation systems) (see Section 3.2.14), constant bright lighting without dark periods, flickering lights (see Section 3.2.11) or persistently high odour levels from poor air management.

3.1.17.2 | Animal-based measures

The ABMs to measure Sensory under- and/or overstimulation are **piling, fear response and inactivity**.

Piling:

- Definition and description: Piling is a behavioural event where a sudden frightening stimulus causes members of the flock to move quickly towards a confined area (e.g. a wall, corner or shelter), resulting in a mass of birds overlapping on top of each other. Birds at the bottom of the pile risk injury, asphyxiation and death (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung).

While the causative stimulus (e.g. loud noise) may not be particularly intense, the overall fearfulness and stress sensitivity of the flock strongly influence the occurrence and extent of piling.

- Interpretation: The presence of piling incidents indicates an underlying sensory overstimulation.

Fear response:

- Definition and description: Fear responses are behavioural or physiological reactions of animals shown towards sudden, threatening and/or novel stimuli (EFSA AHAW Panel, 2023b).

Responses include sudden involuntary movements such as wing flapping, rapid running or freezing following a sensory stimulus (e.g. noise, light flash).

Higher baseline fear levels can lead to stronger and more prolonged fear responses after exposure to sudden stimuli (Anderson et al., 2021).

- **Interpretation:** High frequency or intensity of fear responses suggest the flock to be possibly subjected to either chronic sensory understimulation (leading to birds being more sensitive) or to frequent sudden sensory overstimulation. Interaction effects may occur: turkeys raised in chronically under-stimulating environments may become more sensitive to acute sensory overstimulation events, showing exaggerated flight or fear responses when confronted with unexpected stimuli (Newberry, 1999).

Inactivity

- **Definition and description:** Prolonged periods during the photophase where turkeys remain largely immobile without engaging in exploratory or social behaviours.
- **Interpretation:** High levels of inactivity are associated with sensory understimulation. A high level of inactivity can have other causes such as walking impairment or when birds are kept in sick pens.

3.1.18 | Soft tissue lesions and integument damage

3.1.18.1 | *Description*

The animal experiences negative affective states such as pain, discomfort and/or distress due to physical damage to the integument or underlying tissues, e.g. multiple scratches, open or scabbed wounds, ulcers and abscesses. This welfare consequence may result from negative social interactions (e.g. due to limited resources, causing group stress) such as aggression and injurious pecking, handling, damaging environmental features or mutilation practices (e.g. beak trimming, toe trimming and desnooding) (adapted from EFSA AHAW Panel, 2022b).

3.1.18.2 | *Animal-based measures*

The ABMs to measure Soft tissue lesions and integument damage are: **breast blisters, breast buttons, bruises, cellulitis, wounds, footpad dermatitis and plumage damage.**

Breast blisters:

- **Definition and description:** Breast blisters are cysts filled with liquid under the breast skin produced as a result of repeated bruising of the keel bone or infected feather follicles (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). Blisters vary in size and prominence, ranging from those detectable only by careful palpation of the area to those involving the entire sternal crest (May & Cox, 1970).
- **Interpretation:** The presence of breast blisters is indicative of Soft tissue lesions and integument damage (see also Section 3.3.7).

Breast buttons:

- **Definition and description:** Breast buttons are a form of focal ulcerative dermatitis, sometimes also referred to as breast burns, is a chronic skin alteration affecting the unfeathered skin over the keel of the breast of turkeys (Tilley et al., 1996). Breast buttons are round and donut-shaped areas that originate from inflammation or/and infection forming a hard crust with a core of necrotic skin, and are predominantly seen in toms (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). The ulcer margins are raised, and the centre is filled with a hard scab (Gonder & Barnes, 1987).
- **Interpretation:** The presence of breast buttons is indicative of Soft tissue lesions and integument damage.

Bruises:

- **Definition and description:** A bruise is a superficial injury that occurs after trauma. It results from a haematoma and is often without rupture of the skin (Cockram et al., 2020). This ABM is usually observed at the slaughterhouse after scalding (see also Section 3.3).
- **Interpretation:** The presence of bruises is indicative of Soft tissue lesions and integument damage.

Cellulitis:

- **Definition and description:** Cellulitis is the discoloration and thickening of the skin and inflammation of the subcutaneous tissues, typically caused by high *Escherichia coli* bacteria load combined with skin lesions (Graham et al., 2019) or *Clostridium* species. This ABM is usually observed at the slaughterhouse after scalding.

It affects more toms than hens, occurring at various levels of severity with a prevalence of up to 20% in toms versus 2% in hens (Maillyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). Cellulitis was associated with reluctance to walk, recumbence and pain of tight muscles under palpation in turkeys (El-Helw et al., 2015).

- **Interpretation:** The presence of cellulitis is indicative of Soft tissue lesions and integument damage.

Wounds:

- **Definition and description:** Wounds comprise all lesions to the skin (skin lesions being a disruption in the integument of the skin that has not yet completely healed), ranging from minor superficial punctiform spots to scratches and large open wounds that go deeper than the skin (Welfare Quality Network, 2019).
- **Interpretation:** The presence of wounds is indicative of Soft tissue lesions and integument damage (see also Section 3.3.6).

Footpad dermatitis (FPD):

- **Definition and description:** FPD is a type of contact dermatitis in which the metatarsal and digital pads become swollen, discoloured and hard. Hyperkeratosis, ulceration and necrotic lesions occur and may increase in size and severity as the condition progresses (Mayne, Powell, et al., 2007). These external signs are preceded by histopathological evidence of an inflammatory immune response (Mayne, Else, & Hocking, 2007).

Histological studies indicate that macroscopic scoring of FPD in turkeys corresponds with underlying histological damage, including inflammation, ulceration and necrosis (Nolan et al., 2020). These lesions are likely to cause significant pain and discomfort, affecting the birds' ability to move and perform natural behaviours. Similar to broilers, FPD in turkeys has been associated with the presence of opportunistic pathogens (Alpigiani et al., 2017), which can exacerbate tissue damage and increase the risk of secondary infections. Research has also shown that severe FPD can impact turkey gait, indicating pain-related mobility issues (Mayne, Powell, et al., 2007; Weber Wyneken et al., 2015).

- **Interpretation:** The presence of FPD is indicative of Soft tissue lesions and integument damage. The turkey feet can be affected by diverse levels of FPD, which are indicated by a score; the highest score indicates more severe FPD and more Soft tissue lesions and integument damage (see Section 3.3.2).

Plumage damage:

- **Definition and description:** Deterioration or loss of plumage due to the action of other birds or by erosion, the latter being caused by rubbing against enclosure elements or other birds. It includes damaged feathers and feather loss.

From laying hens, it is known that plumage damage causes negative affective states, regardless of the causal background of the plumage damage (Leishman & Riber, 2025). This is likely to apply also to turkeys.

Depending on the area where the damage to the feather coverage is found, different causes can be hypothesised:

- Severe feather pecking (Group stress, Inability to perform exploratory and foraging behaviour) usually manifests with plumage damage in the anatomical regions of the back, and tail (Haug et al., 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt).
- Damage to the plumage can be caused by barn equipment, e.g. the front of the breast neck can be damaged by the feeder, whereas the wings and tail feathers can be damaged by other housing system components (EFSA AHAW Panel, 2023a).
- In toms older than 16 weeks, the feathers at the back of the head, on the back and thighs may be damaged due to the mating behaviour of males (Marchewka et al., 2015).

Plumage condition can be worse when possibilities for dustbathing behaviour are limited, e.g. if the litter is wet and caked or absent (EFSA AHAW Panel, 2023a) hence it could lead to plumage damage.

Feather loss is associated with higher stress levels, increased susceptibility to skin injuries and thermoregulatory challenges (Vasdal et al., 2021).

- **Interpretation:** The presence of plumage damage indicates Soft tissue lesions and integument damage. The more plumage damage, the worse the welfare consequence (see Section 3.3.4).

3.1.19 | Umbilical disorders and hernias

3.1.19.1 | Description

The animal experiences negative affective states such as discomfort and/or pain due to inflammation of the navel or any type of hernia (EFSA AHAW Panel, [2022b](#)).

3.1.19.2 | Animal-based measures

The ABM to measure Umbilical disorders and hernias is **navel condition**.

Navel condition:

- **Definition and description:** The stage of healing of the navel in poults, including complications such as remnants of yolk, smearing of downs with albumen (i.e. leaky navels), discoloration of the skin surrounding the navel, navel buttons (i.e. scabs formed over the navels) (Mróz et al., [2019](#)) and open navels (Mróz & Orłowska, [2009](#)).

Unhealed navels in newly-hatched poultry species can lead to increased mortality rates, predominantly within the first week of life (Fasenko & O'Dea, [2008](#); Mróz et al., [2013](#)). An open navel may serve as an entry point for pathogenic bacteria, causing infections which can lead to prolonged pain (Rosario et al., [2004](#)).

- **Interpretation:** A poor condition of the navel in turkey poults is indicative of Umbilical disorders and hernias.

3.2 | Identification of the hazards linked to the mandate factors and practices, their relation to the welfare of turkeys, and preventive and mitigation measures

In the following Sections [3.2.1–3.2.15](#), the assessment of the relationship between the hazards linked to each factor and practice listed in ToR B, Requests 2a-f of the mandate, and the identified welfare consequences are reported. Resource- and/or management-based measures allowing the prevention or the mitigation of the identified welfare consequences are also provided.

3.2.1 | Type and condition of the litter

3.2.1.1 | Background

The litter is the substrate, either one or multiple types (e.g. wood shavings, straw), used to constitute the bedding, which covers the floor of the barn before the poults are placed in order to separate animals from the floor, support the feet, absorb humidity of excreta, and to be used for comfort and foraging/exploratory behaviours. When the bedding mixes with excreta/faeces and other material (e.g. feathers, feed) during the entire production period, it is called litter. Litter quality and management can impact the performance and the welfare of the bird through bird-to-litter interactions, moisture content and ammonia concentration (Flores et al., [2021](#)).

The physical structure of the litter in turkey farms depends on the type of bedding substrates used and the accumulation time. Common substrates used as bedding include wood shavings, straw (entire or cut) and sawdust. Rice hulls, peat, sand and recycled paper chips can be found to a lesser extent. Some substrates like rice hulls might cause micro-damage to the feet skin (EFSA's Experts opinion), but no published information about this is available. The type of substrate(s) influences the bulk density, porosity and water-holding capacity of the bedding (Ahn et al., [2008](#); Shepherd et al., [2015](#)). Freshly applied bedding materials tend to be coarse and provide good aeration and absorbency.

3.2.1.2 | Hazards linked with type and conditions of the litter and associated welfare consequences

The welfare consequences that have been identified as relevant in relation to inappropriate litter condition are Resting problems, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Cold stress, Locomotory disorders (including lameness), Soft tissue lesions and integument damage and Respiratory disorders.

Effects of poor litter condition on welfare consequences

'Too high litter humidity' leads to 'poor litter condition' where the litter is caked and/or sticky. Mocz et al. ([2025](#)) compared two types of qualitative scoring for broiler chicken litter versus quantitative humidity measurement in litter samples. There was a strong correlation between visual scoring and humidity level above 35%, while below 35% the litter was looking

dry and friable. Visual scoring of the quality of the litter was more reliable above 35% humidity indicating that litters with humidity above 35% visually look wet and or caked.

'Too high litter humidity' contributes to the development of foot pad dermatitis (FPD). FPD is characterised by lesions of the footpad and toes of different severity and extent, some being painful (Allain et al., 2013). Breast buttons and blisters are also linked to poor litter condition (Mitterer-Istyagin et al., 2011). These lesions are ABMs of the welfare consequence Soft tissue lesions and integument damage.

Krautwald-Junghanns et al. (2013) showed with mathematical models that, when other variables are stable, a hen poult from a farm with an average litter moisture of 20% has a 9.5 times higher chance of a better footpad health status than a poult from a farm with an average litter moisture of 51%. For tom poults, then the chances for a better footpad health increase by a factor of 4.9. In the same study, it was found that already at 3 to 5 days of age, relatively high litter moisture of above 30% could be measured in different areas of the barn, reaching values as high as 70% in specific areas such as around the drinkers. In some cases, very high moisture values were also measured around the feed troughs. On the contrary, sample areas classified as resting areas tended to have the lowest moisture content. Youssef et al. (2010) kept experimental batches of 20 turkeys on (i) dry litter, (ii) on litter moistened with water only, (iii) litter with water and NH_4Cl (as a source of ammonia) or (iv) litter with water and uric acid. The water content of the dry litter in this study was below 14% versus approximately 73% in the moistened litter. The severity of FPD was found to be about 3 times higher on wet than on dry litter. There were no negative effects of ammonia and uric acid on footpad lesions, but the results indicate that high litter moisture is the most likely causal factor for FPD in turkeys.

FPD has been experimentally induced at litter moisture contents of at least 30% (Wu & Hocking, 2011) and (Weber Wyneken et al., 2015), and FPD frequency and severity increase as litter moisture content increases (Hocking & Wu, 2013; Martrenchar et al., 1999; Weber Wyneken et al., 2015). Hocking and Wu (2021) reared 240 male turkeys of 28 days of age under different litter humidity conditions (dry or wet treatment) on litter made of pine wood shavings for 6 days. Average litter moistures were 38% and 82% (SED 6.0), respectively, for the dry and wet treatments. The results showed that FPD severity (scored from 0 = absence to 7 = severe lesions) increases with time, and there is a significant difference between dry (FPD score between 0.23 and 0.4) and wet litter (FPD score between 4.75 and 6.05).

Although not associated with bacterial infection as is the case with FPD (Shepherd & Fairchild, 2010) breast buttons and blisters are other forms of contact dermatitis which share the underlying causal factors of FPD linked to litter condition and type (Mitterer-Istyagin et al., 2011).

Litter provides thermal insulation for turkeys, especially young poults that are more sensitive to temperature changes and Cold stress (see Section 3.1.1). This is particularly important in colder climates or during winter months when temperature control in barns can be more challenging (Grimes et al., 2021b).

Litter is also important in encouraging natural behaviours in turkeys, such as pecking and scratching (see Section 3.1.9), and dustbathing (see Section 3.1.8). Dustbathing in turkeys has been described as a sequence of movements very similar to those exhibited by laying hens (Hale & Schein, 1969). Dustbathing is often performed when wood shavings are replenished (Sherwin & Kelland, 1998). Providing turkeys with a dry and friable litter material allows them to engage in these behaviours, which can reduce stress, improve body maintenance and overall welfare (Bergmann et al., 2013). Turkeys exhibit comfort behaviours like dustbathing more frequently in environments that offer materials such as sand, often provided in outside areas (Berk et al., 2006).

Good litter quality can contribute to healthier, more active birds, potentially reducing the frequency of harmful behaviours like feather pecking and aggression (Group stress). Indeed, a recent study was performed by Leishman et al. (2022) to identify risk factors influencing the prevalence of integument injuries in Canadian turkey flocks, including feather pecking targeting the back/tail area. The results showed that the occurrence of this kind of pecking may be favoured by inappropriate litter conditions.

Hazard for too high humidity of the litter: bedding material

The specific hazard associated with inappropriate litter is unsuitable bedding that can lead to high moisture retention and increased ammonia production, reducing the comfort of the birds.

Different substrates composing the bedding material have varying levels of moisture retention. Fresh bedding materials typically have low initial moisture contents, commonly 10%–15% for materials such as pine shavings, pine bark, chopped straw and hardwood pallets (Bilgili et al., 2009). Shepherd et al. (2017) similarly reported initial moisture values of 10%–16% for most bedding types, while peat moss showed a much higher initial moisture content of about 38%. For example, wood shavings retain less moisture than chopped straw, leading to a lower prevalence of FPD in turkeys (Krautwald-Junghanns et al., 2013). Leishman et al. (2021) conducted a multivariate linear regression modelling based on a questionnaire administered to Canadian turkey farmers. The model showed that FPD prevalence was higher in flocks bedded with straw than with wood shavings. There is a known difference in the level of humidity absorbency of whole straw and chopped straw. However, the study by Leishman et al. (2021) did not clarify whether whole straw or chopped straw was used in the farms. Whole straw offers insulation but is less absorbent than wood shavings, requiring frequent maintenance to prevent matting and compaction, which could lead to wetter litter conditions (Wu & Hocking, 2011).

Furo (2019) also demonstrated that turkeys housed on pine shavings exhibited better comfort levels and fewer footpad issues than those on chopped grass bedding, which doubled the severity of FPD. Highly absorbent and cushioning, bedding material made of wood shavings help maintain dry litter conditions, i.e. reducing FPD. Tilley et al. (1996) showed that

coarse pine shavings resulted in the highest breast buttons rates, while pine sawdust and fine pine shavings produced the lowest rates, indicating that softer, finer litter reduces pressure injuries to the breast area.

Sawdust may also increase respiratory issues due to dust particles (Grimes et al., 2006). Rice hulls maintain dry litter conditions but are available only in specific regions of the EU. Sand has moisture-draining properties but poses challenges due to its weight and lack of decomposition. Recycled paper chips have good absorbency but may compact easily, leading to wet conditions.

Inappropriate bedding material can exacerbate ammonia buildup, which negatively impacts turkey welfare by causing respiratory problems, eye irritation and reduced growth rates (Zhou et al., 2020). Some litter materials, like peat, have properties that help bind ammonia, thus reducing its release into the air (Mayne, Else, & Hocking, 2007). Conversely, materials like sawdust might contribute to higher ammonia levels due to their finer particle size, which binds moisture.

In terms of animal welfare, the preferred bedding is straw (in pellets or chopped) and wood-based bedding such as shavings. Non-chopped straw is not considered efficient. Rice hulls and peat are also good choices for bedding when available. Other bedding materials exist, but no publications are available assessing their impact on turkeys' welfare.

Preventive and mitigation measures for inappropriate bedding

Using absorbent, cushioning materials and adopting proper litter management practices (see Section below on Inadequate management of the litter) are crucial measures for preventing long-term welfare problems in turkeys kept for meat production and breeding. Bedding has different properties and effects on turkey welfare. Cellulose-enhanced bedding (Slobodzian-Ksenicz et al., 2010) was found to slow down bedding encrustation and to reduce leg deformities and improve leg health. The litter stayed drier and more manageable for longer and improved welfare outcomes by reducing mortality and increasing final body weight (Slobodzian-Ksenicz et al., 2010). Grass-based bedding, including chopped straw, was indicated in Krautwald-Junghanns et al. (2013) to be less effective in preventing FPD than wood-based bedding such as wood shavings. Chopped straw was found to be worse than pelletized straw in terms of FPD due to higher moisture retention and poor absorbency.

Regular assessment of litter conditions and timely replacement or replenishment will help maintain a dry and comfortable environment, preventing the risks associated with inappropriate litter material.

Hazard: Inappropriate quantity of bedding material and litter

Proper litter quantity ensures effective moisture absorption, insulation and cushioning, reducing the risk of the welfare consequences mentioned previously. An insufficient quantity of litter reduces the possibility to perform comfort, resting, exploratory and foraging behaviours, leading to reduced welfare. For example, insufficient litter depth can lead to hard, uncomfortable surfaces, preventing turkeys from resting properly (Monckton et al., 2020).

Turkeys naturally engage in pecking and dust-bathing behaviours which may be limited by insufficient litter quantities.

Before placement, the bedding layer covers the floor but is not too deep to allow an easy heating of the floor and the litter as well as easy navigation of the poult to reach resources (EFSA, 2026). When the litter starts to get wet, additional bedding is provided on a regular basis (commonly once or more times a week) (EFSA, 2026). Maintaining an adequate litter depth also helps control ammonia levels and ensures better air quality (Pepper & Dunlop, 2021).

In Europe, the litter is usually removed and replaced entirely between flocks, which allows litter renewal, beneficial for turkeys health and welfare. On the contrary, in other countries outside EU only the top layer is removed and fresh material is added (Mayne, Else, & Hocking, 2007).

Preventive and mitigation measures for inappropriate litter quantity

To prevent welfare issues, bedding is provided throughout the birds' lifetime to promote moisture absorption, support comfort and behavioural expression, and reduce the likelihood of Soft tissue lesions and integument damage. During the production period, good practices can include the addition of bedding material when litter quality starts to deteriorate (e.g. around 7–8 weeks of age) in order to maintain a dry and friable layer on the litter. Partial litter replacement can also be done, particularly when litter conditions become unmanageable due to excessive moisture (due to e.g. leakage or disease outbreaks leading to watery faeces) or ammonia buildup.

Hazard: Inappropriate type of floor

According to expert opinion, concrete floors are commonly used due to their durability and ease of cleaning, providing a solid barrier against predators and pests. For heavy turkeys, concrete without a sufficiently cushioning bedding may be too hard on their feet and joints, potentially leading to mobility issues. Dirt floors (made of soil), in contrast to concrete floors, are another option, offering a softer surface that is gentle on turkeys' feet and joints. However, they provide no protection against predators, especially those that dig. Dirt floors are also challenging to clean and disinfect, necessitating regular maintenance to replenish eroded material. Wooden floors, though less common, are sometimes used in prefabricated sheds. They present challenges in cleaning and are prone to warping and rotting over time. Additionally, wooden floors may offer poor traction when wet, which can pose problems for turkeys. Each floor type has specific advantages and

limitations. The choice depends on factors such as predator presence, maintenance requirements and the specific needs of the turkeys being raised.

Using slatted flooring on certain parts of the barn can help maintain dry litter conditions in some areas of the barn and improve air quality by reducing ammonia levels (Noll et al., 1997). For example, slatted flooring used under drinkers helps drain the spilt water and maintain the litter dry, but they do not offer a comfortable surface for the animals to walk on, and they reduce the surface of available litter, which is necessary for many behavioural needs.

Proper flooring not only ensures turkey comfort but also affects factors like temperature regulation, moisture management and air quality. Depending on the type of barn, the floor can be made of different materials, such as concrete or dirt floors. Inappropriate flooring can lead to abrasion of the skin or impairment in eliminating humidity from litter, leading to wet litter and its welfare consequences (described at the beginning of this chapter). Turkeys that are reared on hard surfaces without adequate litter cushioning are more prone to developing foot lesions and pressure sores, especially when hard surfaces are combined with wet litter (Noll et al., 1997). Floors that have sharp edges or are too abrasive can damage the footpads, making turkeys susceptible to FPD (El-Wahab et al., 2012).

Poor drainage systems can allow water to accumulate under the litter, leading to persistently wet floors. Cracks or damage in the barn floor can permit moisture ingress from the ground or external sources, further exacerbating moisture-related issues. Wet floors can harbour harmful pathogens, leading to an increased risk of infections, including bacterial and fungal ones (Dumas et al., 2011; van der Klis & Veldkamp, 2004).

Preventive and mitigation measures for inappropriate type of floor

Choosing flooring materials that are insulated and easy to clean (e.g. concrete floors) can prevent foot injuries and ensure turkey comfort when associated to adequate type and quantity of litter.

Regular cleaning of the floor and ensuring proper drainage help maintain dry flooring conditions, preventing the buildup of harmful bacteria and ammonia.

Specific hazard: Inadequate management of the litter

Litter in turkey barns is managed through a combination of ventilation, litter turning, litter addition/replacement during the cycle and use of litter additives. Each of these practices helps maintain a dry and comfortable litter and environment for turkeys, reducing the risk of Soft tissue lesions and integument damage, Locomotory disorders (including lameness), Respiratory disorders, Resting problems, Inability to perform comfort behaviour and Inability to perform exploratory or foraging behaviour.

The specific factors described below are responsible for increased litter moisture and decreased litter quality, leading to the welfare consequences listed above.

Barn ventilation is a key aspect of litter management, as it helps to remove moisture and ammonia from the barn environment. Indeed, adequate airflow reduces the accumulation of moisture in the litter by facilitating the evacuation of water. Barn management practices include adequate ventilation to maintain proper temperature, hygrometry and air quality as well as optimal litter conditions and overall flock health (Beaulac et al., 2019). Insufficient ventilation can lead to wet litter.

Ventilation systems are typically adjusted based on the season and environmental conditions (temperature/humidity), with higher ventilation rates required during humid weather to prevent litter from becoming too damp (Bergmann et al., 2013). Farmers use mechanical ventilation or passive ventilation to contribute to maintain dry litter conditions and reduce the buildup of ammonia.

Aeration and turning, consisting of regularly turning or stirring/raking the litter, avoids compaction (EFSA, 2026), promotes moisture distribution and encourages the breakdown of waste by aerobic microbial activity and reduces **moisture content** within the litter by accelerating the drying process when it is combined with effective ventilation (Pepper & Dunlop, 2021). On the other hand, (2011); Miles et al. (2008) measured very low or no NH_3 release from compacted or caked litter. Caked litter is characterised by high moisture, low pH and high ammonium (as NH_4) concentration (Miles et al., 2008). Brink, Janssens, and Delezie (2022a) studied the effect on NH_3 volatilisation with or without raking at different litter humidities. They showed that the development of a crust on top of the litter (no raking) reduces the formation and concentration of NH_3 volatilised from the litter.

As caked litter is not adequate for turkeys to perform exploration, foraging and comfort behaviours, it is important to add new bedding regularly. First, this prevents the litter from becoming compacted and caked; second, it absorbs moisture and helps dilute the faeces, reducing nitrogen concentration in the litter and thereby limiting ammonia production. Addition of new bedding (replenishment, with the same or different bedding material) contributes to effective moisture absorption and reduces ammonia levels compared to friable litter with higher faeces concentration. Holt et al. (2023) showed that regularly adding new bedding promotes activity and better health in broilers.

Removing wet litter from the barn and replacing it with dry bedding (Carrol, 2012) can improve litter quality and limit ammonia production. The new material added can be new bedding or dry litter that is transferred from the surrounding floor if there is sufficient quantity. Carrol (2012) showed a positive effect of litter replacement on the health and welfare of broiler chickens.

The use of chemical or biological litter additives is common practice in turkey farming to improve litter conditions, but no publications are available to assess the impact on turkey welfare. Additives such as alum, sodium bisulfate and acidifiers are often applied to bind ammonia and reduce its release into the air (Bilgili et al., 2009). Some farmers also use biological treatments, such as microbial inoculants, to enhance the natural breakdown of organic matter and control pathogen levels in the litter, but no scientific publications are available assessing these additives for turkeys. Incorporating additive materials like biochar (carbon-rich material produced by heating organic matter) into the litter can help absorb excess moisture and reduce bacterial growth (Flores et al., 2021), preventing and eventually mitigating welfare issues.

Visual scoring of litter by farmers is necessary to monitor and maintain good litter quality (not too high humidity in litter). Visual scoring systems are available for daily litter assessment (EURCAW Poultry SFA, 2025). Automated systems for measuring ammonia concentrations and humidity can be used in turkey barns to provide real-time data, allowing for quick adjustments of ventilation, heating or litter management practices (Anisha et al., 2024; Volkmann et al., 2024).

Water nipples, if not adapted or deficient, can lead to leaking and/or spillage of water that will add humidity to the litter (Houldcroft et al., 2008). In broilers, the same authors showed that bell drinkers, which can be used as an alternative to nipple drinkers (Appleby et al., 2004), allow birds to drink more naturally but are also more liable to spillage, which can have an impact on litter quality (Jones et al., 2005).

Preventive and mitigation measures for inappropriate litter management

High moisture content also promotes microbial growth and decomposition processes, which can accelerate nutrient loss, especially nitrogen in the form of ammonia volatilisation (Cai et al., 2006; Miles, 2011). The best litter moisture content to minimise the risk of the litter getting wet and caked during the production cycle is typically between 20% and 30% (Mayne, Else, & Hocking, 2007). Proper management of moisture levels is essential to reduce odour and maintain optimal litter quality (Pepper & Dunlop, 2021).

Scoring of litter should be used to monitor litter quality and apply preventive and corrective methods.

As a preventive method, ventilation should be adjusted to the size and characteristics of the barn, the climatic conditions and the age, stocking density and health status of the turkeys to prevent the humidity in the litter from becoming too high.

Aeration and turning of the litter, and/or addition of new bedding contribute to preventing wet litter.

Partial replacement of wet litter by new bedding is a mitigation method to improve litter quality.

Use of additives to control humidity, ammonia emission and bacterial proliferation can help maintain optimal litter conditions.

Hazards of specific importance for young poult and breeders

Young turkey poults are especially vulnerable to poor litter conditions due to their underdeveloped immune systems and high sensitivity to environmental factors (e.g. temperature). The early stages of life are critical for turkey development, and exposure to wet or compacted litter can hinder their growth, compromise immune function and increase stress levels (Bessei et al., 2021; Shehata et al., 2021). Flooring type greatly affects the ability of turkeys to regulate body temperature, which is especially important for young poults who are sensitive to temperature changes (Farghly et al., 2018).

Turkeys kept for breeding, which are housed for longer periods than meat production turkeys (58–59 weeks vs. 12–22 weeks), are more at risk of the negative welfare impact if reared with poor litter conditions. Indeed, extended exposure to inadequate litter conditions can result in chronic foot health issues, such as FPD and leg deformities. Kaukonen et al., 2016 explored the effect of litter quality on FPD, hock burns and breast blisters in broiler breeders throughout their production period. Wetter litter was linked to poorer footpad condition, although the direct impact of litter quality on severe lesions was not statistically significant. The AHAW Panel suggests that the link between wet litter and FPD is likely also present in turkey breeders, comparable to turkeys kept for meat production or broiler breeders. Despite improvements in some litter conditions, footpad health continued to decline with age, suggesting that factors beyond the litter environment contribute to FPD (Kaukonen et al. (2016).

3.2.2 | Type and availability of enrichment

3.2.2.1 | *Background*

Newberry (1995) defined environmental enrichment as ‘an improvement in the biological functioning of captive animals resulting from modifications to their environment’. She suggested that the aim of enrichment is to improve the biological functioning of captive animals. Later, Riber et al. (2018) described the following purposes of providing environmental enrichment: (1) to prevent or reduce abnormal behaviours and improve physical health; (2) to reduce negative affective states and to increase the positive affective states and utilisation of the environment; (3) to increase animals' ability to cope with challenges associated with meeting key behavioural motivations and physiological needs; and (4) to increase the occurrence and types of species-specific and motivated behaviours. In line with this, Dannenbrink and Berk (2008) concluded that environmental enrichment provides turkeys with the opportunity to perform a wider range of behaviours.

However, scientific knowledge on the effect of environmental enrichment on turkey welfare is generally limited, specifically knowledge on how the design, availability and location of enrichment in the barn affect turkey behaviour and welfare (VKM, 2016).

Two different enrichment types have been described in the literature: point-source objects and more complex enriched environments (Riber et al., 2018; van de Weerd & Day, 2009). Point-source objects are types of enrichment that are generally limited in size and restricted to a single or a few locations in the barn. Examples are perches, platforms, visual barriers, strawbales and pecking objects (Dong, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals). If enrichment is provided as point-source objects, several types may be offered simultaneously, which usually increases the total time spent interacting with the enrichment, particularly if the various types of enrichment address different behavioural motivations. For example, turkeys provided with a platform for resting and a straw bale for foraging and exploration exhibited higher levels of enrichment use than turkeys provided with just one of the two types of enrichment (Dong, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals). More complex enriched environments differ more radically from conventional production systems and have been designed to better meet the key behavioural motivations of the animals within them (van de Weerd & Day, 2009). This may be either complex indoor systems or systems providing access to covered verandas, outdoor ranges or both.

3.2.2.2 | *Hazards linked with different types of enrichment and their associated welfare consequences*

The welfare consequences relevant for turkeys, which may be affected by the hazards inappropriate enrichment, insufficient enrichment and absence of enrichment, are Heat stress, Group stress, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Locomotory disorders (including lameness), Resting problems, Sensory understimulation and Soft tissue lesions and integument damage.

In Section 3.2.2.3, for each of the different types of enrichment used in turkey farming, the scientific knowledge on the turkeys' use of enrichment and how that affects the associated welfare consequences is described. In addition, assessments of how the hazards inappropriateness, insufficient quantity and absence of the different types of enrichment influence the welfare consequences are provided.

A major gap of knowledge for all the types of point-source enrichment objects is the quantity of enrichment needed per individual to prevent or mitigate the different welfare consequences listed above, i.e. knowledge on the number of places in the barn where the enrichment should be provided and the amount of the enrichment to be provided for all animals to have access. If an insufficient quantity of enrichment is provided, then it may create competition among the turkeys, which could increase the level of group stress and the risk of soft tissue lesions and integument damage.

No literature was found specifically on the use and effects of enrichment in turkey breeders, except for one study on elevated structures (Marks, 2017). However, the EFSA experts believe that the behavioural needs and motivations, when it comes to environmental enrichment, are similar for breeders to those of turkeys kept for meat production.

3.2.2.3 | *Elevated structures*

Perching on elevated structures (e.g. straw bales, perches and platforms) is part of the behavioural repertoire of turkeys (Cathey et al., 2007). This behaviour is an antipredator response that is necessary for the survival of wild turkeys, and domestic turkeys likely perch at night when possible as a result of comparable motivations (Bessei, 1999). When kept under commercial conditions, turkeys will perch or attempt to perch on any elevated structure available (Dong, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals), indicating that they are strongly motivated to perch. Perching occurs both during the day and night time, although significantly more during the night (Marks, 2017; Platz et al., 2006; Stratmann & Ringgenberg, 2023). Bessei (1999) pointed out that the motivation to perch is present in all turkey genotypes. Preventing the turkeys from fulfilling this motivation may lead to resting problems.

Elevated structures are point-source enrichment objects. Inappropriate, insufficient or absence of elevated structures may result in the welfare consequences Resting problems, Group stress and Soft tissue lesions and integument damage.

Hazards: inappropriate, insufficient and absence of elevated structures

In turkeys kept for meat production, perch and platform use peaks between the age of 4 and 11–12 weeks and decreases afterwards (Berk & Hinz, 2002; Dong, 2022; Lindenwald et al., 2021; Martrenchar et al., 2001; Spindler & Hartung, 2009; Stratmann & Ringgenberg, 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt). In turkey breeder hens provided with two types of platforms and a perching rod during rearing, use of all types of elevated structures decreased from week 5 to 28 of age, whereas they used the available perching possibilities at a constantly high level throughout the 25-week observation period in the laying period (Marks, 2017). However, perching is initiated at an earlier age if the design of the elevated structures allows turkeys to access the structures. For example, Lindenwald et al. (2021) provided platforms at three different heights (0.1, 0.7 or 1.3 m above floor level) accessible from the floor or the platform below (no ramps) and noted during casual observations that the platform at the lowest level to be used already on day 1 of age, whereas the middle and upper levels were used from day 16 of age. A mean of 24% of the turkeys used the platforms on the first observation day, which occurred when the birds were 8 days old. In addition, it should be noted that in some studies the decrease in use of elevated structures with age may be partly due to decreasing space allowance on elevated

structures as the birds grow larger (e.g. Lindenwald et al., 2021; Martrenchar et al., 2001; Stratmann & Ringgenberg, 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt).

Turkey hens use elevated structures more than toms, which has been suggested to be due to their lower body weight and better mobility (Martrenchar et al., 2001; Stratmann & Ringgenberg, 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt). For example, Stratmann & Ringgenberg (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) found that only a few toms used the elevated structures provided beyond the age of 11 weeks of life, regardless of the type of structure. It should be noted that no ramps were provided for easy access to the elevated structures.

The study of Stratmann & Ringgenberg (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) included different types of elevated structures (wooden planks, i.e. wide-width perches and platforms made of plastic grids of different dimensions) and straw bales. The two types of platforms made up approximately 4% and 3% of the floor surface area in hens' and toms' pens, respectively. The wooden planks were 15 cm wide and placed at alternating heights of 50 and 60 cm. Straw bales were placed on both sides of the platforms until the 8th week of life to help turkeys move between platforms and litter area. Compared to both types of platforms, the planks were used the least by both sexes, confirming the findings by Martrenchar et al. (2001). This was particularly evident in the toms, which may be explained by their heavier body weight. The platforms likely provide better support due to the larger surface area and therefore they may be more comfortable for the toms to roost on. Although the planks were less preferred compared to the platforms, particularly for the toms, the use of the planks increased until approximately 5 weeks of age and stayed constant until the end of the observation period (12 and 16 weeks of age for hens and toms, respectively). This indicates that for turkey hens, planks may, to some extent, fulfil the requirements of elevated structures, although platforms are preferred.

Perch use has been shown to result in breast blisters in heavy turkey toms (Berk & Hahn, 2000), whereas studies housing turkeys with elevated platforms have reported no incidence of breast blisters (Stratmann & Ringgenberg, 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) or lower prevalence of breast blisters when compared to toms housed without elevated platforms (with vs. without platforms: 6.3% vs. 13.8%) (Berk & Hinz, 2002). In terms of accessibility, planks and particularly platforms seem more suitable compared to perches, particularly at the end of the production cycle as birds are heavier and their mobility is reduced (Lindenwald et al., 2021). It has been shown that the genetic selection for heavy turkeys has resulted in their centre of gravity being moved towards the breast, causing balance difficulties (Abourachid, 1991). Bircher et al. (1996) found that 5 cm wide perches were used more by young turkey toms (4–6 weeks of age) than 11 cm wide perches, whereas the opposite was found for older turkey toms (7–14 weeks of age), and drew the conclusion that for the perches to be appropriate for turkeys, the width of the perches should match the size of the turkeys such that they offer a good grip for young turkeys and provide support of feet and breast for older and heavier turkeys. Stratmann & Ringgenberg (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) observed more successful transitions, defined as all downward and upward movements without any obvious problems visible, on the platforms compared to the planks. They concluded that it is easier for turkeys to jump onto a flat, large surface rather than a plank which is narrower and more resembling a perch. Structures like straw and hay bales may also provide the possibility for perching behaviour, but older or less mobile turkeys may experience problems accessing the bales. In addition, the birds will destroy and scatter the straw and hay bales because of their foraging and exploratory behaviour, for which reason the bales have to be renewed regularly if their purpose is to function as elevated structures (Martrenchar et al., 2001). Ramps have been shown to increase the use of elevated structures considerably in turkeys (Bircher et al., 1996). Likewise, Stratmann & Ringgenberg (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) suggested that access to platforms would be facilitated by ramps, and that the presence of ramps likely could reduce the occurrence of difficulties when birds are moving vertically. The slope of the ramps likely plays a role in how effective they are, as reported from a study on broiler chickens, where a higher use of ramps having a slope of 18° compared to 25° was found (Khalfi et al., 2024). The optimal slope of ramps has, to our knowledge, not been investigated in turkeys.

Accessibility to elevated structures may also be influenced by stocking density. A study by Berk and Hinz (2002) showed that the daytime use of elevated structures (platforms and straw bales) in turkey toms (B.U.T. Big 6) depended on stocking density in the barn, with more birds perching at the lower than the higher stocking density (average from 2 to 21 weeks of age: 50% at 1.5 birds/m² vs. 30% at 3.5 birds/m²). The higher stocking density is likely to have restricted access to the elevated structures.

Furthermore, accessibility depends on the quantitative provision of elevated structures per turkey. Research is limited to only one study investigating this aspect (Marks, 2017). In this study, the use by turkey breeder hens of two types of platforms and one type of perch (11 cm wide) was examined. The platforms differed in terms of the surface material, although both were made of plastic slats. In the rearing phase, all birds were simultaneously offered the two types of slatted platforms as well as the perching rod. During the laying phase, the average body surface (i.e. the area covered by the bird while in a resting position; 0.15 m²/hen) and the average body width (0.35 m/hen) of the turkey breeder hens were determined by use of image planimetry. No data were provided on body weight, but based on the genotypes, the hens likely weighed approximately 12 kg during the laying period. The proportion of the total area taken up by turkeys on the platforms was determined, resulting in 126% (platform A) and 132% (platform B) use of platforms during the dark period, and 22.6% (platform A) and 21.5% (platform B) use of platforms during the light period. A ratio of more than 100% indicates that part of the turkeys on the platforms was extending outside the platform area, or the turkeys were squeezing together, indicating insufficient platform area availability and a high motivation to use the platform for nighttime roosting. Correspondingly, the ratio of the total width of the number of perching turkeys to the perch length was determined, resulting in 99.8% use

of the perches during the dark period and 28.0% use during the light period. Based on this, Marks (2017) recommended for turkey breeder hens 0.35 m perching rod per bird or 8.5 birds/m² platform. Additionally, it was concluded that the platform width should be selected such that the turkey breeder hens can line up in two rows to maximise the use of the platform area (i.e. approximately 0.6 m). The space allowance needed on platforms and planks differs across the different animal categories (meat turkeys vs. breeders), sexes and target weights, but data on average body surface and width only exist for breeder hens (Marks, 2017). The RSPCA standards for meat turkeys recommend sufficient perch length for 40% of the birds to be able to perch simultaneously at any given time, with the specification that the perch length needed to accommodate one bird is 40 cm. This translates to 16 cm perch per individual within a flock (RSPCA, 2023). It is unclear on which evidence these recommendations are based.

The presence of platforms has been shown to reduce injurious pecking, leading to better plumage condition and fewer skin injuries compared to turkeys housed with no elevated structures for perching (Lindenwald et al., 2021). The authors proposed that the reduction of injurious pecking was either achieved by the platforms providing shelter or a general reduction in stress.

Providing elevated structures is thought to enhance poultry's ability to regulate body temperature by allowing them to escape the heat from decomposing litter and benefit from airflow from underneath (Gebhardt-Henrich et al., 2017; Riber et al., 2018). Furthermore, broilers with access to elevated structures may have fewer Locomotory disorders (including lameness) (Pedersen & Forkman, 2019). To the best of our knowledge, neither the effects of elevated structures on Heat stress nor on Locomotory disorders (including lameness) have been investigated in turkeys; however, in the opinion of EFSA experts, it is likely that the provision of elevated platforms for fast-growing meat turkeys can also play a role in the prevention or mitigation of Heat stress.

3.2.2.4 | *Foraging and exploratory material*

Wild turkeys spend a considerable amount of their active time on foraging and exploratory behaviours. A master's thesis reported that approximately 50% of the photoperiod was spent foraging by wild turkeys in the US (Huebner, 2010). Foraging and exploratory behaviour consists of searching for (potential) food items by walking and pecking, though the pecking can also be expressed alone, directed towards the available materials (Dalton et al., 2018). Scratching the ground with one or two feet may occur, but typically rather infrequently. The behavioural pattern has been preserved in the domestic turkey, although the proportion of time taken up by foraging and exploratory behaviour may be reduced compared to the wild counterpart (Hammond et al., 2024a; Hughes & Grigor, 1996).

To accommodate the motivation of turkeys for foraging and exploratory behaviour, the suitability of various types of exploratory and foraging materials as environmental enrichment has been examined. This includes straw and hay/alfalfa bales, baskets with straw or hay, corn silage, scattering of insect larvae or wheat grain feeders, edible pecking blocks and non-edible pecking objects, as reviewed in this section. Grit is sometimes considered enrichment, but it is a basic, essential resource along with feed and water, whose main function is to aid the gizzard in grinding the feed and therefore it does not fulfil the criteria for enrichment (Riber et al., 2018).

If turkeys cannot perform exploratory and foraging behaviours, secondary welfare consequences may develop. This includes group stress, which may be reflected in increased soft tissue lesions and integument damage due to injurious pecking (Berk et al., 2018; Sherwin et al., 1999a). Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals) found a higher average proportion of turkey toms redirecting pecking behaviour towards structures in the environment (not enrichment) in the control group than in the toms in the treatment group when both a straw bale and a platform were provided. Pecking behaviour may also be redirected towards conspecifics. Martrenchar et al. (2001) provided turkeys with straw and metal objects and found a reduced frequency of injurious pecking in males and fewer injuries of the wings (toms and hens) and tail and head (toms) compared to turkeys housed in unenriched environments. Likewise, Sherwin et al. (1999a) found that turkey toms provided with wheat straw as foraging material experienced reduced wing and tail pecking injuries or no head pecking injuries compared to the control birds housed without enrichment. Providing black soldier fly larvae in feed troughs as a type of foraging material has also been shown to reduce injurious pecking directed at the back and tail base of turkeys, with a tendency to reduce the prevalence of feather and skin damage (Veldkamp & Van Niekerk, 2019). However, some studies found no preventive effect of foraging material on injurious pecking behaviour (strawbales: Letzguß (2010); strawbales and pecking blocks: Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals); insect larvae: Meyer (2018), Glawatz et al. (2019)). Different explanations for the lack of effect may apply. For example, in the study by Letzguß (2010) occurrence of injurious pecking was very low in all treatments. The method of observation may also play a role. Although Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals) found no difference between treatments in the observed occurrence of injurious pecking, the turkey toms in the treatment enriched with strawbales had improved feather quality, which could indicate that the observation method insufficiently detected differences in performance of injurious pecking behaviour. Finally, Meyer (2018) and Glawatz et al. (2019) seem to be based on a demonstration study lacking any replicates of the treatments.

Availability of appropriate exploratory and foraging material may lower the risk of Locomotory disorders (including lameness), likely due to an increase in the overall activity level, including locomotion. In a small experimental study, an environment enriched with a number of different pecking objects (chains, ropes, cabbage) resulted in a longer latency to lie in a test of leg health, interpreted as improved musculoskeletal function of turkey toms (Sherwin et al., 1999a). Similarly,

provision of strawbales or pecking blocks has been shown to postpone the onset of gait problems in turkeys compared to unenriched conditions (Dong, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals).

Foraging and exploratory material is a type of point-source enrichment. Absence, insufficient or inappropriate foraging and exploratory material may lead to the welfare consequences Inability to perform exploratory or foraging behaviour, Group stress, Soft tissue and integument damage and Locomotory disorders (including lameness).

Hazards: inappropriate, insufficient quantity and absence of foraging and exploratory materials

The use and effect of exploratory and foraging material depend on the type of material provided, the frequency of renewal of the material and the accessibility of the material.

Berk et al. (2018) investigated the use of different types of foraging materials. They found that the materials (wire basket with hay, pecking blocks, wheat grain feeders, extruded wheat grain, crispbread) were used from the moment when they were offered (i.e. at 2 weeks of age) onwards by both turkey toms and hens, though pecking blocks and wheat grain feeders were more used compared to the other materials. In later trials, where only wheat grain feeders were provided to beak-intact toms from week 10 of age, the use of these was shown to differ strongly between individuals, but still the number of lesions inflicted due to injurious pecking was reduced compared to control turkeys without access to wheat grain feeders. Later, Kulke et al. (2019) showed that corn silage seems to remain attractive to turkeys for longer than wheat.

Bales of straw or hay promote foraging behaviour, first locally where they were placed, and then in a growing area as the turkeys progress in destroying the bales and scatter the straw or hay. Martrenchar et al. (2001) provided straw (13 kg bale of non-chopped straw, placed on the litter and replaced when necessary) and metal objects (reflective galvanised iron sheets (W×H: 15 cm×20 cm) hooked on metal chains at birds' head height) for single-sex housed turkeys (B.U.T. 9) during the rearing period. Both sexes were observed pecking at the straw and the metal objects, but the percentage of birds performing exploratory and foraging pecking was higher for the straw than for the metal objects, and hens appeared to lose interest in the metal objects as the percentage of hens pecking the metal objects decreased steadily with age, whereas pecking at straw remained at the same level. In line with this, Crowe and Forbes (1999) found that more foraging behaviour was expressed by turkey toms provided with straw or grains spread in the litter compared to toms provided with non-edible pecking objects (changed weekly). Within the non-edible pecking object treatment, peaks in object pecking were noted when the object had a string-like appearance or was easily manipulated by the beak. Duggan et al. (2014) showed that turkeys housed with coloured plastic balls as enrichment did not differ from control turkeys in injurious pecking behaviour, indicating that the plastic balls were an ineffective type of exploratory enrichment for prevention of injurious pecking. This might be due to the non-friable/non-manipulable/non-edible nature of plastic balls, and to the long-time presence of the balls causing habituation and loss of novelty (Duggan et al., 2014). These results suggest that non-edible pecking objects do not suffice as exploratory and foraging material, as there is a high risk that this type of enrichment is not effective in satisfying the exploration and foraging motivations and will ultimately not prevent or mitigate the welfare consequences it was intended for. In contrast, edible foraging materials such as straw, corn silage, wheat grain feeders and pecking blocks seem to remain attractive, resulting in higher use and prevention of the welfare consequences associated with inappropriate or absence of exploratory and foraging material.

Crowe and Forbes (1999) found an increased occurrence of injurious pecking in turkey toms provided with either chopped straw three times per week or grain scattered twice a day as compared to turkeys provided with perches, non-edible pecking objects or no enrichment. The authors speculated whether the enrichments led to increased competition due to insufficient frequency of provision and quantity of the straw and grain distributed. No other behavioural differences were found between turkeys provided with straw or scattered grain and turkeys in unenriched environments, except that the latter spent more time standing than turkeys provided with straw. Thus, the study demonstrated the risks associated with insufficient provision of exploratory and foraging enrichment. Similarly, competition due to insufficient access to the enrichment material may also explain why access to a pecking block worsened the feather quality of neck, coverts and wings compared to unenriched control turkeys in the study by Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals).

Another type of foraging material examined for use in turkeys is insect larvae, distributed either manually in the litter or via an automatic conveyor system. Studies have shown that live insect larvae are highly attractive to turkey poults (Van Niekerk & Veldkamp, 2017) and turkey toms (Glawatz et al., 2019; Meyer, 2018). However, in a demonstration study (i.e. no replicates of the treatments), the toms seemed to partly lose interest at around 14/15 weeks of age (Glawatz et al., 2019; Meyer, 2018), perhaps due to the onset of sexual maturity. Veldkamp and Van Niekerk (2019) reported inconsistent effects of the provision of live insect larvae on the occurrence of foraging behaviour. Thus, the provision of live insect larvae, although likely experienced as an enrichment for turkeys, may not fulfil the criteria of being effective as a foraging material in prevention of the associated welfare consequences, which may be linked to insufficient quantity and frequency of provision, as the larvae are typically quickly depleted.

Whereas the suitability of different types of foraging material has been investigated, no research studies have been identified addressing the quantity of foraging material needed to have a positive influence on animal welfare. Quantities recommended can be found in standards for animal welfare labels, but it is unclear on which evidence these are based. For example, RSPCA welfare standards for turkeys set the following minimum requirements for every 500 turkeys: (a) one large (e.g. 250 kg) or two small (i.e. conventional rectangular, approximately 18 kg) strawbales, (b) 2 metres of perch space (in addition to strawbales) and (c) two strings (RSPCA, 2023). However, such minimum requirements will only allow a minor proportion of turkeys within a flock to have access to the enrichment at a time.

3.2.2.5 | Visual barriers

Visual barriers, such as tunnels and panels, add extra wall space in the housing environment, which may in itself be considered an environmental enrichment, as it is known from broiler chickens that walls are preferred locations for resting (Arnould et al., 2001; Buijs et al., 2010). In broiler chickens kept in barren environments at a high stocking density, individuals resting along the walls are less disturbed by conspecifics (Forslind et al., 2021). This is likely also the case in turkeys, but it remains to be investigated.

In addition, visual barriers may function as hides or shelter for turkeys being harassed by conspecifics or being victims of injurious pecking. For example, Lindenwald et al. (2021) provided turkeys with a 'turkey tree', which was a structure consisting of three platforms at different heights (0.1, 0.7 and 1.3 m above floor level). The authors noted that the lower level in the turkey tree provided visual barriers and seemed to be used as a sort of shelter.

Visual barriers are point-source enrichment. Inappropriate, insufficient and absence of visual barriers may lead to the welfare consequences Resting problems, Group stress and Soft tissue lesions and integument damage.

Hazards: inappropriate, insufficient and absence of visual barriers

Sherwin et al. (1999a) examined the effectiveness of enrichment of simultaneously providing visual barriers (free-standing wooden boards), chromed chains, strips, supplemental UV light and long-cut wheat straw from day 3, in reducing injurious pecking behaviour and pecking injuries in turkey toms. The enrichment treatment was found to reduce wing and tail pecking injuries and prevent head pecking injuries compared to the control group, but the effect of the visual barriers specifically cannot be deduced from the study.

Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals) investigated the use and effect of access to a tunnel (0.61 m length × 0.61 m width × 0.58 m height), which functioned as a shelter. Provision of tunnels resulted in better wing feather quality and cleanliness compared to the control group. When comparing the use of different types of enrichment (examined in separate treatment groups), tunnels were used less frequently than platforms. No effects of the tunnel treatment were found on beak-related behaviours (i.e. preening, environmental pecking and injurious pecking), neither compared to the control group or any of the other enriched groups.

The two studies above describe two types of visual barriers, but studies on the general characteristics needed for a structure to function appropriately as a visual barrier are lacking. Similarly, no studies have examined the minimum quantity of visual barriers needed for them to be effective in preventing the associated welfare consequences in turkeys.

3.2.2.6 | Dust baths

Dustbathing is considered a comfort behaviour associated with positive affective states (Mellor, 2015; Papageorgiou et al., 2023). Dustbathing is performed by different poultry species, including turkeys (Duncan et al., 1991), but research into dustbathing behaviour has focused on laying hens (*Gallus gallus domesticus*), whereas investigations of dustbathing behaviour in turkeys are rare.

Dust baths are point-source enrichment objects. Inappropriate, insufficient or absence of dust baths (in addition to litter) may result in the welfare consequence Inability to perform comfort behaviour, which may further lead to Group stress and Soft tissue lesions and integument damage due to injurious pecking.

Hazards: inappropriate, insufficient and absence of dust baths

Studies on dustbathing in turkeys are sparse. In the EKE on the proportion of time turkeys spend dustbathing, the EFSA experts elicited the time budget for dustbathing to be 0.31% (90% certainty interval [0.05, 1.35]) (see Section 3.2.3). In a study performed in naturally ventilated barns either with or without access to a covered veranda, observations of dustbathing were relatively rare (Berk et al., 2006). Sherwin and Kelland (1998) reported that conventional turkeys (male B.U.T.8) were not observed to dustbathe during the selected observation periods, but subsequent studies revealed that dustbathing was frequently performed when the litter (wood shavings) was replenished, suggesting that the litter characteristics, e.g. dryness and friability, are important for the performance of dustbathing in turkeys.

3.2.2.7 | Complex enriched environment with/without covered veranda

Inappropriate, insufficient and absence of a complex enriched environment with/without covered veranda may lead to the welfare consequences Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation.

Complex enriched environments consist of indoor housing equipped with multiple types of enrichments, targeting sense of agency and different motivations and therefore have the potential to affect several welfare consequences. This is often combined with less intensive indoor housing conditions, such as reduced stocking density, and/or the use of hybrids with lower growth rates and target body weights. In some cases, access to a covered veranda is provided, offering exposure to fresh air, the outdoor climate, more space and potentially elevated structures and different flooring, foraging

and pecking materials and dust baths (an example of the latter: EURCAW-Poultry-SFA (2023a)). Research into the use of and potential welfare consequences of complex enriched environments with/without covered verandas in turkeys is limited. One study confirmed that turkey toms used the covered veranda from when they were given access at 6 weeks of age up to the end of the fattening period (Berk et al., 2006). On average, 350 toms (range: 9–990) were present in the covered veranda during the observations, corresponding to 10% of the flock size. The use of the covered veranda differed between weeks of observations and was also affected by the time of the day. At weeks 7, 9 and 11 of age, fewer turkeys visited the covered veranda during the winter as compared to the summer, whereas no difference was found between seasons for the remaining fattening period (13–21 weeks of age).

Complex enriched environments provide many different stimuli and will therefore reduce the risk of the welfare consequence Sensory understimulation. The available resources targeting different motivations are likely to reduce group stress and injurious pecking (i.e. soft tissue lesions and integument damage), as described under the different point-source types of enrichment earlier in this section. Access to a covered veranda increased the time spent active (Berk et al., 2006), and from broiler chickens it is known that increased time spent active may improve walking ability (Reiter & Bessei, 2009). A similar effect is likely to be found in turkeys, as Dong (2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Eurogroup for Animals) showed that the onset of gait problems was postponed in turkeys kept in enriched compared to unenriched conditions, whereas Sherwin et al. (1999a) found indications of improved musculoskeletal function in turkeys provided with a range of different types of enrichments simultaneously. Furthermore, reduced stocking density, another common characteristic of complex enriched environments, has been shown to improve walking ability in turkeys (Martrenchar et al., 1999), i.e. reduce the risk of locomotory disorders (including lameness). This may apply to both complex enriched environments with covered veranda (this section) or outdoor range (see Section 3.2.2.8).

Hazards: inappropriate, insufficient and absence of complex enriched environment with/without covered veranda

In a pilot study, four consecutive AUTHOR: Please check Section 1.3.6 cited in text, but not available in proof. flocks of turkeys for meat production, kept either in a conventional barn without enrichment or in a naturally ventilated barn with access to a covered veranda structured with straw bales, were compared (Berk et al., 2006). The toms with the covered veranda were lying less and performed more locomotion, standing, wing flapping, wing stretching, ground pecking and feather pecking in comparison to the control flocks. In the treatment having access to a covered veranda, more active behaviours were performed in the covered veranda compared to the indoor area. The total mortality was lower in the flocks housed with access to a covered veranda (range: 5.1%–7.0%) compared to the flocks housed in a conventional barn (range: 7.0%–10.4%). The results of the study suggested that access to a covered veranda prevented Locomotory disorders (due to increased activity level), Inability to perform comfort behaviour and Inability to perform exploratory or foraging behaviour in turkey toms.

No studies have addressed how space allowance in the covered veranda affects the relevant welfare consequences in turkeys. Recommendations can be found e.g. in standards for animal welfare labels, but it is unclear on which evidence these are based. In Germany, the industry organisation Verband Deutscher Putenerzeuger² (VDP) stipulates that in conventional turkey production, a covered veranda can occupy a maximum of 25% of the usable indoor floor area (Verband Deutscher Putenerzeuger, 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Landwirtschaftskammer Nordrhein-Westfalen). The maximum limit is set to guarantee efficient indoor ventilation in open-sided houses. In contrast, the RSPCA of Australia standards for turkeys specifies that if a veranda is provided and included in the calculation of usable area, then the usable area in the veranda must be at least 33% of the indoor usable floor area (RSPCA, 2020). The Beter Leven 1-star standards detail that if a veranda is provided, the surface must be at least 20% of the surface area of the indoor floor area (Beter Leven, 2016 retrieved from EFSA Public call for evidence - PC-0741 1 - Dierenbescherming). Based on expert opinion, a covered veranda having a floor area corresponding to 20% of the indoor useable floor area has been recommended in the latest EFSA Scientific Opinions on the welfare on farm of broilers and laying hens (EFSA AHAW Panel, 2023a, 2023b). The recommendation details that the floor area of the covered veranda is not included in the calculation of the indoor useable floor area. This is based on the argument that, as one of the objectives of the covered veranda is to provide extra space to the animals, while not being accessible all the time, it should not be counted as usable area. This would be similar in relation to housing of turkeys.

No studies have examined from which age access to a covered veranda is appropriate for turkeys, i.e. when they can physically tolerate the outdoor climate. It varies from 4 to 10 weeks of age, but the most common practice seems to be between 6 and 9 weeks of age, depending on weather conditions (EFSA, 2026). This coincides with the transition from the brooding barn to the fattening barn, which typically occurs when turkeys are 6 weeks of age (EFSA, 2026). Until the turkeys are fully feathered at 6 to 8 weeks of age, they are vulnerable to harsh weather conditions (Grimes et al., 2021a). Since the covered veranda provides an outdoor area that is to some extent protected from inclement weather, first access may be possible even before turkeys are fully feathered. This will require proper design to ensure that young turkeys can also use the popholes and easily return to the indoor barn, allowing them to carry out behavioural thermoregulation by moving between areas (indoor vs. covered veranda) at different microclimatic conditions. This may be the reasoning for the Beter Leven 1 standards to stipulate access to a covered veranda from 35 days of age (Beter Leven, 2016 retrieved from EFSA Public call for evidence - PC-0741 1 - Dierenbescherming), but it remains unclear on which evidence the recommendation is based. Important aspects of the design to take into account are the length of popholes per 100 m² indoor area and the levels of the popholes, veranda and indoor floor, which should either be similar or, if different, manoeuvrable ramps should be provided.

3.2.2.8 | *Complex enriched environment with outdoor range*

Inappropriate, insufficient and absence of a complex enriched environment with outdoor range may result in the welfare consequences inability to perform exploratory or foraging behaviour, inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation.

A complex enriched environment with outdoor range may be similar to the complex enriched environment with/without a covered veranda explained in the previous section, but in addition an outdoor range is offered. How a complex enriched environment with outdoor range may mitigate the relevant welfare consequence is similar as described earlier for a complex enriched environment with/without a covered veranda (see Section 3.2.7.1 covered veranda). An outdoor range offers a variety of stimuli that motivate locomotion, foraging, exploration and dustbathing and therefore have the potential of affecting turkey welfare. Only few studies have addressed the use and effects of complex enriched environments with outdoor range on turkey welfare.

Flocks of turkeys having outdoor range access seem to have lower mortality compared to turkeys housed indoor, but robust studies are missing. Berk and Hinz (2002) reported lower mortality in turkeys housed with outdoor access, but no data were provided, whereas Spindler (2007) found a consistently lower mortality rate in turkeys housed with outdoor access compared with turkeys with no outdoor access, but due to the low number of replicates the statistical power of the study was limited and no significant differences were found. Studies have found that access to an outdoor range reduces skin injuries in turkeys, but often access to an outdoor range in these studies is confounded with different stocking densities or genotypes because the factor of interest is production system (e.g. organic vs. conventional) and not outdoor access per se (e.g. Ermakow, 2012). However, Berk (2003) found fewer breast blisters and breast buttons in turkey tom carcasses housed with access to an outdoor range. Likewise, Spindler (2007) found that turkey toms (B.U.T. Big 6) housed at comparable stocking densities (with or without outdoor access: 2.5 vs. 2.8 birds/m²) had fewer skin injuries at slaughter if having outdoor access. In an experimental study, Haug et al. (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) found fewer injuries at the wings and back, but more injuries at the neck and head in turkey toms reared from day-old with access to enrichment (pecking stones and elevated platforms) and then moved to mobile houses during the fattening period (9–20 weeks of age) with access to an outdoor area, pecking stones, elevated platforms and alfalfa silage as compared to turkey toms housed indoor without access to enrichment. Plumage damage due to feather pecking varied between the treatments depending on age and body part, being at some ages lower for some body parts in the turkeys kept in the mobile houses with outdoor access and vice versa, but overall, there was no difference found.

Hazards: inappropriate, insufficient and absence of complex enriched environment with outdoor range

The use of an outdoor range and a covered veranda by turkey toms (B.U.T. Big 6) has been investigated in a trial covering summer and winter seasons (Berk, 2003; Berk & Hinz, 2002). Access to the outdoor area and covered veranda was granted daily from 6 weeks of age during the hours 8:00–19:00. Fewer turkeys were observed in the outdoor range with increasing age, i.e. on average 70% and 20% of the flock were found in the outdoor range at 7 and 21 weeks of age, respectively. This may be linked to lower mobility due to the increasing body weight with age. Access to outdoor ranges was stated to reduce mortality (no data provided). Use of the outdoor range was influenced by weather conditions. As outside temperatures dropped, the turkeys preferred the roofed area of the outdoor range (no data provided). In line with this, Platz et al. (2006) found that turkeys reared with outdoor access made high use of the platforms in the outdoor range for nighttime roosting during the summer (approximately 18%–28%, depending on genotype and feed (conventional vs. organic)), whereas they preferred the indoor area during the winter, with the frequency of nighttime roosting on the platforms in the outdoor range dropping to around 3%. The authors concluded that the outdoor range should include platforms, a roofed area and indoor access. Other factors, such as type and height of vegetation and presence of shelters, are likely also important, but studies are lacking.

Likewise, no studies have investigated the effect of different outdoor space allowances on the welfare of turkeys or the appropriate age at first access. Like for some of the other enrichments, recommendations can be found e.g. in standards for animal welfare labels, but it is unclear on which evidence these are based. The Beter Leven 2-stars standards details that if an outdoor range is provided, the space allowance should be 6 m² outdoor area per turkey for a minimum of 8 h per day and access should be given no later than at 50 days of age (Beter Leven, 2016 retrieved from EFSA Public call for evidence - PC-0741 1 - Dierenbescherming). The common age at first access to an outdoor range seems to be 6–9 weeks of age, which is age at which the turkeys are fully feathered (Grimes et al., 2021a).

3.2.3 | *Space allowance*

3.2.3.1 | *Background*

The mandate asks to assess the risks related to the factor space allowance, i.e. the available space per bird (m²/bird). In meat producing birds such as turkeys, the stocking density (expressed either as birds/m² or kg/m²) is more commonly used to reflect space allowance and therefore this term is also used throughout this SO (EFSA, 2026 for an overview of current national requirements for stocking density in some EU MSs and Norway). A high stocking density is a proxy for a low space allowance. The relationship between stocking density and space allowance can be influenced through changes in available space or number

of birds. Therefore, available space and group size are often confounded in the scientific studies because only one factor is manipulated at a time. Usually group size is manipulated to change the available space per bird rather than the pen size, making it difficult to separate their individual effects on the welfare of turkeys (Erasmus, 2017; 2018; Marchewka et al., 2013). Given the variation in how data are reported in scientific literature, as well as the variation in turkey husbandry and management, comparison of different scientific studies is challenging (Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). However, it may be possible to infer space allowance from stocking density or vice versa when sufficient information is provided. For example, when the space allowance is reported in number of birds per floor space, a conversion to stocking density would require data on the body weight or age and genotype (to estimate body weight). In contrast, when stocking density is provided, either the number of birds and available space or age and genotype to estimate weight, should be reported to infer space allowance.

3.2.3.2 | *Hazards linked with space allowance and its associated welfare consequences*

'Insufficient space allowance' (or 'too high stocking density') is the main hazard linked to the relevant welfare consequences of Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour and Inability to perform exploratory or foraging behaviour. Other welfare consequences may be exacerbated by 'too high stocking density' (i.e. Locomotory disorders (including lameness), Soft tissue lesions and integument damage, Heat stress, Gastroenteric disorders and Respiratory disorders); however, these relationships are more indirect, and this is highlighted throughout the text.

Several reviews have been published on the effects of stocking density on turkey behaviour, welfare and production (e.g. Erasmus, 2017; Krautwald-Junghanns & Sirovnik, 2022; Marchewka et al., 2013). These were used as the basis for evaluating the literature regarding stocking density and supplemented with newly identified literature. Due to the variability in reporting of stocking density, the units provided by the original authors are used. Effects on production are considered out of scope of this mandate and not further described.

Too high stocking densities lead to a lack of space for turkeys to perform certain behaviours, leading to Restriction of movement and inability to manoeuvre around or avoid each other, which can make it more difficult to access resources such as feed and water (Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). Beaulac and Schwan-Lardner (2018), Beaulac et al. (2019) and Jhetam et al. (2022a, 2022b) retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt published a series of experiments to evaluate the effects of increasing stocking densities (30, 40, 50, 60 kg/m²) on the behaviour, health, welfare and production of turkey toms and hens (genotype: Nicholas Select). Behaviours were assessed based on 24 h recordings using 20-min interval scan sampling at 8 and 11 weeks of age for hens and 12, 14 and 16 weeks of age for toms. They evaluated the presence of linear and quadratic relationships between the behaviour and the stocking density and presented results as regression equations (linear or quadratic). For sake of clarity, we only report the regression coefficient of the linear relationships. For the quadratic relationships, we report the shape of the parabola as negative (parabola will open downward) or positive (parabola will open upward), indicating higher or lower occurrence of the behaviour at the intermediate stocking densities (40, 50 kg/m²) compared to the extreme stocking densities (30, 60 kg/m²).

In both turkey hens and toms, there was a negative linear relationship between stocking density (30, 40, 50, 60 kg/m²) and the percentage of turkeys walking, and this relationship remained consistent over the different time points when behaviour was assessed. The only exception was for the 16-week time point in toms, where there was a positive quadratic relationship, suggesting a lower percentage of walking at the intermediate stocking densities compared to the extreme stocking densities (Beaulac & Schwan-Lardner, 2018; Jhetam et al., 2022b). Additionally, Beaulac et al. (2019) observed a decrease in feed consumption in turkey toms from 12 to 16 weeks of age at higher stocking densities. As feeder space had been allocated on a per-bird basis, the decrease was not due to a lack of available feeder space alone, something that could be observed when stocking density is increased without providing more feeder space. Instead, the authors suggested that the decrease in feed consumption was because of the greater difficulty in manoeuvring throughout the room combined with the poorer mobility of some turkeys at this age under higher stocking density (Beaulac et al., 2019; Beaulac & Schwan-Lardner, 2018).

Poor mobility can reflect Locomotory disorders (including lameness), which can be assessed through the ABM of walking ability/gait score. There was a linear increase in gait score at increasing stocking densities in turkey toms at 16 weeks of age (+0.02 increase in gait score per kg/m²), with a higher gait score indicating worse mobility (Beaulac & Schwan-Lardner, 2018). In turkey hens, stocking density did not influence gait score at 8 or 11 weeks of age (Jhetam et al., 2022b). It is possible that stocking density only influences gait scores when hens are older and heavier. Martrenchar et al. (1999) found more hens with poor mobility at 12 weeks of age when decreasing space allowance from 16 dm²/hen (16.7% with score > 0) to 12.3 dm²/hen (38% with score > 0) and 10 dm²/hen (51.2% with score > 0).

The influence of stocking density on Resting problems can be assessed through the ABM disturbances during resting. Though no studies could be found on the effects of different stocking densities on resting in poults, or their long-term implications on turkey welfare, it is suggested that disturbances of resting poults by active poults are common in ring-rearing systems in the first days of life (Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). More is known about resting behaviour in older turkeys. Martrenchar et al. (1999) reported that increasing stocking density in turkeys (genotype: B.U.T., no further specification available) had little effect on behaviours observed over two experiments, though the amount of time resting without disturbances tended to be lower in turkey hens and toms at higher stocking densities. However, they only observed birds during specific time periods during the day and recommended future studies to cover the full photoperiod.

The percentage of turkey toms resting did not differ between stocking densities (30, 40, 50, 60 kg/m²) at 12 weeks of age, but a linear relationship (+0.39 percentage per increase in kg/m²) was observed at 14 weeks of age and a negative quadratic relationship at 16 weeks of age (more resting at the intermediate stocking densities) (Beaulac & Schwan-Lardner, 2018). The authors suggested that at 60 kg/m², turkeys had insufficient space to rest comfortably and therefore spent more time standing than at 50 kg/m². Interestingly, the total number of disturbances during resting was only related to stocking density at 12 weeks of age, with more disturbances observed at the lower stocking density, which the authors attributed to higher mobility at the lower stocking density (30 kg/m²). In turkey hens, the percentage of turkeys resting increased linearly with increasing stocking density at 8 (+0.23 percentage per increase in kg/m²) and 11 weeks (+0.43 percentage per increase in kg/m²) of age (Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). While turkey hens rested more at increasing stocking densities, there was also a linear increase in the percentage of severe disturbances where turkeys stood up as a result of another turkey walking in front or on top of them, or flapping their wings near them (Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). It is suggested that providing elevated structures or access to an outdoor range may decrease the frequency of resting disturbances while reducing stocking density in a barn (reviewed by Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). However, stocking density also influences the turkeys' use of these features, and their role on welfare consequences in turkeys is described in Section 3.2.3.

'Too high stocking density' can lead to inability to perform comfort behaviour, though this may differ according to sex and age of the turkeys (Beaulac & Schwan-Lardner, 2018; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). With increasing stocking density (30, 40, 50, 60 kg/m²) there was a linear increase in the percentage of turkey toms preening (+0.05 percentage per increase in kg/m²) and performing other comfort behaviour, which was a combination of stretching, wing flapping, dustbathing, head scratching, feather ruffling (+0.0057 percentage per increase in kg/m²) at 14 weeks of age (Beaulac & Schwan-Lardner, 2018). This relationship remained for preening behaviour at 16 weeks of age but was no longer observed for other comfort behaviours. This research group performed a similar experiment with turkey hens (Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). In this case, no relationship between stocking density and preening behaviour was observed at 8 or 11 weeks of age. The authors analysed the different comfort behaviours separately and found some negative quadratic relationships (more comfort behaviours at intermediate stocking densities) between stocking density and dustbathing (at 8 weeks of age), as well as head scratching (at 8 weeks of age, while at 11 weeks of age there was a negative linear relationship). These studies highlight that stocking density may affect behaviours differently depending on turkey age and sex, i.e. the relationships between stocking density and behaviours are not straightforward. It should also be noted that the estimates for the regression coefficients were relatively small in these studies, likely due to the behaviours occurring at a low frequency (Beaulac & Schwan-Lardner, 2018; Jhetam et al., 2022b).

Stocking density may also be related to inability to perform exploratory or foraging behaviour. Environmental pecking, including pecking at the walls, feeder tubes, drinker lines or litter, was not influenced by stocking density in turkey toms at 12, 14 or 16 weeks of age in a study of Beaulac and Schwan-Lardner (2018). In turkey hens, there was similarly no effect observed on environmental pecking at 8 and 11 weeks of age (Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). However, when considering litter pecking separately, there was a linear decrease (−0.06 percentage per increase in kg/m²) with increasing stocking density at 8 weeks of age (Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt).

Stocking density may also influence social behaviours between turkeys (Erasmus, 2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU); Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU); Marchewka et al., 2013) and thus Group stress, and ultimately welfare consequences such as Soft tissue lesions and integument damage. Turkeys show different forms of injurious pecking, including feather pecking, cannibalistic pecking and aggressive pecking (Dalton et al., 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). Jhetam et al. (2022a) showed an increase in feather pecking with increasing stocking density in turkey hens at 11 weeks of age (+0.01 percentage per increase in kg/m²), while for turkey toms no such relationship was observed (Beaulac & Schwan-Lardner, 2018). However, in both turkey hens and toms, the overall feather score decreased with increasing stocking density, implying worsening of the feather cover at all time points (Beaulac & Schwan-Lardner, 2018; Jhetam et al., 2022b). Plumage damage is often used as a proxy to assess feather pecking, as the behaviour itself may be overlooked depending on the observation protocol used.

A higher percentage of turkey toms showed aggressive pecking at 16 weeks of age with increasing stocking density (+0.0019 percentage per increase in kg/m²) (Beaulac & Schwan-Lardner, 2018). The authors also included a behavioural category they called dominance, which included fighting, strutting and posturing, but this was not affected by stocking density (Beaulac & Schwan-Lardner, 2018). Unfortunately, these behaviours were not analysed separately, especially considering that strutting may have different motivational backgrounds and is an ABM of the welfare consequence Restriction of movement (Section 3.1.16). The percentage of turkey toms treated or culled for damage likely resulting from aggression over 0–16 weeks was not affected by the stocking densities investigated, but when toms were between 4 and 8 weeks of age they experienced the highest incidence of damage likely resulting from aggression at 30 and 60 kg/m² (3.3% and 8.9%, respectively) compared to 40 and 50 kg/m² (2.5% and 2.3%, respectively) stocking densities (Beaulac & Schwan-Lardner, 2018).

Buchwalder and Huber-Eicher (2004) observed low numbers of fights or leaps when introducing an unfamiliar turkey to a group of five toms in a small pen (6 m²; 1 m²/turkey) or large pen (78 m²; 13 m²/turkey). They had expected an increase

in fights or leaps in the small pen, but no difference was observed. They speculated that turkeys avoided fighting when in the small pen under higher stocking density because the lack of space prevented them from performing the fighting behaviour and increased the risk of injuries to wings in a restricted space. Instead, more aggressive pecks and threats were performed in the small pens compared to the large pens (Buchwalder & Huber-Eicher, 2004).

For turkey hens, there was a small negative linear relationship between stocking density and fighting (-0.0086 percentage per increase in kg/m^2), and a small positive quadratic relationship between stocking density and aggressive pecking, though these relationships were only observed at 8 weeks of age (Beaulac & Schwan-Lardner, 2018). The authors suggested that the higher levels of fighting and aggressive pecking at lower stocking densities may be because turkeys are more active at lower stocking densities. This was also reflected in the total percentage mortality and culls due to injuries from aggressive behaviour, which decreased as stocking density increased (-0.018 percentage per increase in kg/m^2) (Jhetam et al., 2022a). As such, mortalities and culls were, respectively, 0.68%, 0.58%, 0.52% and 0.09% for the stocking densities of 30, 40, 50 and 60 kg/m^2 .

Several studies have also reported that other ABMs associated with Soft tissue lesions and integument damage, but not necessarily associated with Group stress, can increase with increasing stocking density, though differences between ages and sexes may exist in turkeys (Erasmus, 2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU); Krautwald-Junghanns & Sirovnik, 2022 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU); Marchewka et al., 2013). These ABMs are mainly related to forms of contact dermatitis, such as footpad dermatitis and breast blisters, and may be more indirectly mediated through the impact of stocking density on litter moisture. Higher stocking density is associated with greater litter moisture (Beaulac et al., 2019) due to a proportionally larger volume of excreta and increased covering of the litter by birds, which potentially limits the air circulation to assist with the drying of litter. Noll et al. (1991) reported litter moisture levels between 30.2% and 31.4% at low stocking density (0.46 m^2/bird ; 13 birds) as opposed to litter moisture levels between 36.5 and 40.8% at high stocking density (0.21 m^2/bird ; 28 birds). More recent studies also report higher levels of litter moisture with increasing stocking densities in turkeys, though the precise relationship is dependent on the age of the turkeys (Beaulac et al., 2019; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). The effects of too high litter moisture on the ABMs of Soft tissue lesions and integument damage, such as footpad dermatitis, are described in Section 3.2.1.

Stocking density is often mentioned as a risk or predisposing factor for various diseases in poultry (Swayne et al., 2020), even though it may not be the direct cause of disease. Stocking density may impact the transmission of pathogens through increased bird-to-bird contact or immunosuppression (Swayne et al., 2020). Research on broilers showed that higher stocking densities predisposed birds to necrotic enteritis (Tsiouris et al., 2015). Assuming similar mechanisms (increased bird-to-bird contact, immunosuppression) at play in turkeys, this could suggest that 'too high stocking density' in turkeys could increase the risk of Gastroenteric disorders. Feather dirtiness, which is an ABM for gastroenteric disorders (although other factors may be the cause – Section 3.1.4), increased with increasing stocking densities in turkey hens and toms (Beaulac & Schwan-Lardner, 2018; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). No other signs of Gastroenteric disorders were recorded in these studies.

The suggestion that stocking density may impact the immune or stress response of turkeys has been investigated in limited studies with inconclusive results (Beaulac & Schwan-Lardner, 2018; Hafez et al., 2016; Jhetam et al., 2022b retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Djurens Rätt). For example, Hafez et al. (2016) found no difference in immune response to Newcastle disease, avian metapneumovirus or *Ornithobacterium rhinotracheale* in turkeys housed at stocking densities of 25, 48 and 58 kg/m^2 . However, stocking density in this study was confounded with the housing in the two farms where the study was conducted. Stocking density may also indirectly impact Respiratory disorders through increased levels of dust or ammonia (Section 3.2.4). The incidence of airsacculitis was higher (25.0% vs. 11.7%) in turkey toms (Large White, Nicholas strain) at 20 weeks of age kept at a high stocking density (0.21 m^2/bird ; 28 birds) compared to a low stocking density (0.46 m^2/bird ; 13 birds) (Noll et al., 1991). However, other studies reported no difference in incidence of lung lesions in turkeys kept at low or high stocking density (2.8 birds/ m^2 or 5.5 birds/ m^2 , respectively), though authors described a tendency for more severe lung lesions (as indicated by more observations of larger-sized lesions) in turkeys kept at high stocking densities (Perkins et al., 1995; Zuidhof et al., 1993). In the experimental conditions in which these studies were performed, there was also little to no impact of stocking density on environmental parameters such as dust particles, NH_3 or CO_2 , which could explain the lack of differences in Respiratory disorders (Perkins et al., 1995; Zuidhof et al., 1993). This highlights that management factors such as ventilation and litter conditions may play a larger role than stocking density per se. It should also be noted that these studies are dated, and recent studies were not available.

Perkins et al. (1995) additionally investigated the frequency of the ABM gasping at different stocking densities in turkey toms (Hybrid genotype) on the day before slaughter at 16 weeks of age. They observed 31% of turkeys gasping at a high stocking density (5.5 birds/ m^2) compared to 6% of turkeys gasping at a low stocking density (2.8 birds/ m^2) when increasing the room temperature to 30°C for 1 h. This implies that Heat stress may be more severe in turkeys kept at higher stocking densities, however, to the best of our knowledge, no studies have been published to elucidate this further. Beaulac et al. (2019) reported a quadratic increase in litter temperature measured at 18 and 36 mm depth with increasing stocking density from 30, 40, 50 to 60 kg/m^2 but no ABMs of Heat stress were recorded in this study. However, this is in line with the literature from broilers, which states that high stocking density increases heat generation, and impedes heat transfer and drying capacity from the litter surface (Bessei, 2006; EFSA AHAW Panel, 2023a). It is expected that the relationship between stocking density and Heat stress is similar in turkeys.

3.2.3.3 | Results from the Expert knowledge elicitations and the behavioural space model to estimate the minimum space allowance of turkeys

In this section, the results of the semi-formal EKEs to estimate the distributions for the different input parameters for the behavioural space model and the results of the behavioural space model are presented. The space requirements of a flock of turkeys were calculated based on the minimum space needed for an individual turkey to perform a certain behaviour, while also accounting for the minimum inter-individual distance between turkeys and the proportion of time spent on behavioural classes (some behaviours may require more space but occur relatively infrequently, e.g. dustbathing).

Planimetric space for the different behavioural classes

Results from the EKE on planimetric space occupied for stationary behaviours are presented in Table 4 and Figure 3. Toms (genotype: B.U.T. 6) were used in all studies included in the EKE, representing a modern heavy line of turkeys, which makes extrapolation of available data to hens or other genotypes (traditional or medium line) the main uncertainty. Based on expert knowledge, it was assumed that toms have taller bodies than hens at the same weight and therefore take up relatively less space. Traditional genotypes of turkeys may also be shorter and wider than the modern genotypes at the same weight and therefore take up relatively more space. This is in line with Ellerbrock and Knierim (2002) who proposed that, as turkeys become larger, the amount of space occupied per unit of body weight decreases. For more details on the evidence and the EKE conducted, please see Appendix III-B to F.

TABLE 4 Results from the expert knowledge elicitation for planimetric space occupied (cm²) for stationary behaviour in turkeys at the five selected slaughter weights.

Slaughter weights (kg)	5th percentile	Median	95th percentile
7 kg	842 cm ²	1047 cm ²	1187 cm ²
12 kg	1213 cm ²	1350 cm ²	1487 cm ²
16 kg	1284 cm ²	1534 cm ²	1693 cm ²
20 kg	1437 cm ²	1653 cm ²	1830 cm ²
25 kg	1575 cm ²	1795 cm ²	1985 cm ²

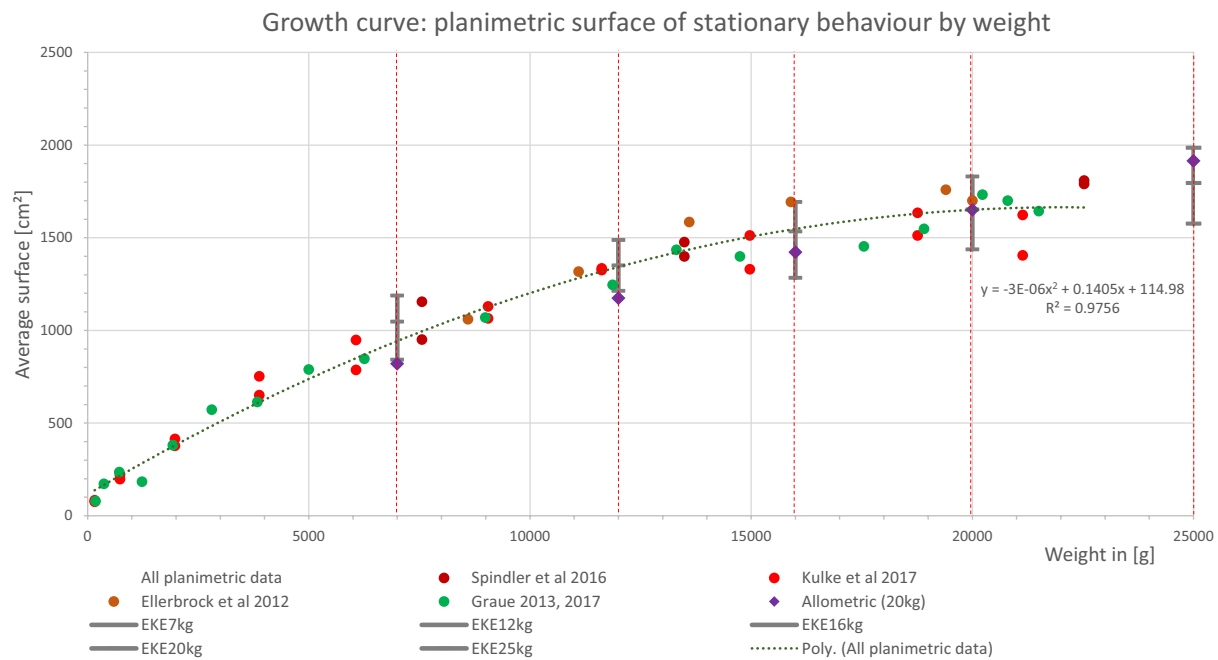


FIGURE 3 Curve depicting the average surface area occupied (cm²) according to body weight (g) of turkeys. Individual dots represent data points from the four studies that provided planimetric data (Ellerbrock & Knierim, 2002; Graue et al., 2013; Kulke et al., 2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover; Spindler et al., 2016 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover). The EKE was performed at 7, 12, 16, 20 and 25 kg (results indicated by grey vertical lines with horizontal dashes for the median and 90% certainty interval), and data were also extrapolated to all weights from the judgement on turkeys of 20 kg using allometric scaling (purple diamonds). A quadratic regression line was fitted to indicate the trend of the data points (grey dotted line indicated as 'Poly. (All planimetric data)').

No planimetric data were available in the literature for the other classes of behaviours (dynamic behaviours, other comfort behaviours, wing flapping, dustbathing and strutting) included in the behavioural space model. The space that these behaviours occupy was calculated by considering the morphological data on dimensions of turkeys (Berk, 2024b personal communication; Ribalta Alet & Campoy Atlés, IRTA 2024 personal communication; Appendix III-G), and determining the adjustment factors for hens and toms performing the different classes of behaviour (Appendix III-H). The morphological data on dimensions came from measurements of B.U.T. 6 and B.U.T. Premium turkeys (hens at days 90–97, toms at days 112–135 of age) collected at the slaughterhouse after shackling but before feather removal (Appendix III-G). The adjustment factors showed minor variation and indicated that, in comparison to stationary behaviour, particularly the behaviour of wing flapping required more space. The planimetric space of the stationary behaviour in turkeys of the different weight categories was multiplied by the adjustment factor to calculate the occupied space by hens or toms of different weight categories when performing each behaviour (Table 5). The method is described in Section 2.2.5, detailed calculations are in Appendix IIIA.

TABLE 5 Planimetric space (cm²) occupied by hens (7, 12, 16 kg) and toms (16, 20, 25 kg) for stationary, dynamic, other comfort behaviours, wing flapping, dustbathing and strutting. The planimetric space for stationary behaviour is multiplied by adjustment factors accounting for the morphological dimensions of birds performing the behaviour and assuming an elliptical model (Figure 1) to calculate the space occupied when performing all classes of behaviours. Strutting is only performed by toms.

Behavioural class	Planimetric space of different classes of behaviour for hens and toms of different weights at slaughter							
	Hens				Toms			
	Adjustment factor	7 kg	12 kg	16 kg	Adjustment factor	16 kg	20 kg	25 kg
	[–]	[cm ²]			[–]	[cm ²]		
Stationary behaviours	Reference	1047	1350	1534	Reference	1534	1653	1795
Dynamic behaviours	1.56	1633	2106	2393	1.61	2470	2661	2890
Other comfort behaviours	2.97	3110	4010	4556	2.84	4357	4695	5098
Wing flapping	4.26	4460	5751	6535	3.97	6090	6562	7126
Dustbathing	2.31	2419	3119	3544	2.23	3421	3686	4003
Strutting	na				1.43	2194	2364	2567

Estimation of inter-individual distance

No specific studies were available on the inter-individual distance of turkeys while performing the different classes of behaviour in the framework of the behavioural space model. Only one experimental study reported on distances between individual turkeys (Buchwalder & Huber-Eicher, 2004). In this study, an unfamiliar turkey was introduced to a small group of five toms in an experimental pen, and the ratio of the mean distance between the introduced turkey and the other turkeys versus the mean distance among the five familiar turkeys was smaller in a small pen (100 vs. 93 cm) than large pen (151 vs. 116 cm). This, and the finding that the number of pecks towards the introduced turkey was higher in the small compared to the large pen, led the authors to suggest that a distance above 50 cm appeared to be sufficient to reduce the number of aggressive pecks (Buchwalder & Huber-Eicher, 2004). As this was the only study which focused on negative behaviours in a specific test with a small group of turkeys, which is likely different from the situation in commercial flocks, EFSA experts used the morphological data to extrapolate the inter-individual distance between turkeys (Appendix III-G). Dimensions of different parts of the body (e.g. neck to beak, body length, wing length, Appendix III-A) indicate the necessary inter-individual distance, particularly for the avoidance of possible contacts between turkeys or injurious pecking. The EKE on the inter-individual distance was performed for hens and toms separately due to differences in slaughter weights and body morphology.

Different classes of behaviours likely have different inter-individual distances in turkeys. However, the EFSA experts were not able to assess the distances separately for each class of behaviours. Due to the absence of specific measurements for inter-individual distance for each class of behaviours, only one value was elicited. It corresponds to an average inter-individual distance weighted by the proportions of a particular behaviour in a turkey flock, and results are reported in Table 6.

For hens (Appendix III-I), the inter-individual distance elicited from EFSA experts was 31.8 cm (with a 90% certainty range from 17.2 to 60.8 cm). For toms (Appendix III-J), the inter-individual distance elicited was 42.3 cm (with a 90% certainty range from 23.8 to 69.3 cm). The reasoning behind the elicited upper limit considers that turkeys try to avoid touching each other while expressing the different behaviours. Thus, for wing flapping, it implies a distance of twice the wing length to ensure two birds can flap their wings while standing next to each other, and for dynamic behaviour it implies twice the body length. The elicitation of the lower limit considers that turkeys attempt to distance themselves from a conspecific to protect against injurious pecking with an average neck-to-beak length between individuals. Uncertainties were discussed due to observations of shorter inter-individual distances, which may be caused by limited resources (e.g. total space, space on elevated platforms, length of perches, feeder and drinker space), which force turkeys to reduce the inter-individual

distances. The EFSA experts judged that lower values are more likely than higher values for inter-individual distances as stationary behaviour is more frequent than other behaviours, and stationary behaviour is assumed to have shorter inter-individual distances. This is reflected in the elicited median value, which is closer to the lower end of the elicited values for inter-individual distance.

TABLE 6 Results from the expert knowledge elicitation for inter-individual distance for toms and hens.

Inter-individual distance	5th percentile	Median	95th percentile
Toms	23.8 cm	42.3 cm	69.3 cm
Hens	17.2 cm	31.8 cm	60.8 cm

Estimation of the proportion of time spent on behaviours

Semi-formal EKEs (EFSA Scientific Committee, 2018) were conducted to estimate the proportion of time spent on dynamic behaviours, other comfort behaviours, dustbathing, wing flapping and strutting. Strutting only occurs in toms, and dynamic behaviour was stratified by sex as differences between sexes were expected. Since data did not cover slaughter age or weights, the time budget was estimated for 8 weeks of age in hens and 14 weeks of age in toms. The EFSA experts considered a scenario for a flock with no limitation of resources (e.g. space, elevated structures) observed during the photophase. Assuming the average percentage of time turkeys spent on a certain behaviour, and variation between flocks due to different farm conditions, the EFSA experts were asked to judge the time budget of a more active flock expressing dynamic behaviours, other comfort behaviours, dustbathing, wing flapping and strutting for toms only (see Appendix III-K to P).

No EKE was performed for stationary behaviours, instead it was calculated using the fact that the proportion of time spent on all behavioural classes should add to 100%. The proportion of time spent on stationary behaviours was calculated by subtracting the proportion of time spent on wing flapping, dustbathing, other comfort behaviours, dynamic behaviours and strutting (toms only) from 100% (see Appendix III-Q to R). The final time budgets of the turkeys for the six classes of behaviours are presented in Table 7. Toms spent less time on dynamic behaviours and more time on stationary behaviours compared to hens.

TABLE 7 Time budget (%) during the photophase in hens and toms for the 6 classes of behaviours. Data are reported as median value with the 90% certainty interval in square brackets. Strutting is only performed by toms.

Behaviour	Time budget during the photophase	
	Hens	Toms
Stationary behaviours	60.1% [49.7%–71.8%]	69.2% [60.7%–77.1%]
Dynamic behaviours	25.1% [14.7%–34.0%]	11.2% [6.4%–17.3%]
Dustbathing behaviour	0.31% [0.05%–1.23%]	
Wing flapping	0.48% [0.15%–1.15%]	
Other comfort behaviours	9.2% [5.3%–14.4%]	
Strutting	–	3.5% [0.7%–6.6%]

Outcomes of the behavioural space model

The minimum space requirements as calculated by the behavioural space model differ according to the sex and weight of the birds. Results are presented as minimum space allowance and maximum stocking density in Table 8. The stocking density ranges from 14.5 kg/m² for light hens of 7 kg (corresponding to 2.07 hens per m²) to 30.4 kg/m² for heavy toms of 25 kg (corresponding to 1.22 toms per m²) and 31.7 kg/m² for heavy breeding toms during the production period of more than 26 kg (corresponding to 1.22 toms per m²).

The characteristic of the model is to allow the turkeys to perform the behavioural pattern and hold enough inter-individual space between each other, but assume minimal unnecessary free space. This is expressed by a homogeneous distribution, which would, in the case of more space, change to more clustered behaviour of the turkeys, leaving parts of the space unused. Therefore, the results of the model should be seen as a minimal estimate.

TABLE 8 Minimum space allowance (cm²/turkey) and maximum stocking density (turkeys/m² and kg/m²) resulting from the behavioural space model for turkey hens and toms at different slaughter weights. Maximum stocking density is expressed in number of turkeys per m² as well as body weight (kg) per m². Results are presented as median value and 90% certainty interval in square brackets.

Sex	Hens			Toms			
Slaughter weight	7 kg	12 kg	16 kg	16 kg	20 kg	25 kg and more	> 25 kg ^a
Minimum space allowance per turkey (cm ² /turkey)	4839 [3135, 9338]	5660 [3791, 10,390]	6097 [4150, 11,061]	7493 [4798, 12,440]	7814 [5073, 12,926]	8211 [5378, 13,346]	8189 [5373, 13,391]
Maximum stocking density (turkeys/m ²)	2.07 [1.07, 3.19]	1.77 [0.96, 2.64]	1.64 [0.90, 2.41]	1.33 [0.80, 2.08]	1.28 [0.77, 1.97]	1.22 [0.75, 1.86]	1.22 [0.75, 1.86]
Maximum stocking density (kg/m ²)	14.5 [7.5, 22.3]	21.2 [11.5, 31.7]	26.2 [14.5, 38.6]	21.4 [12.9, 33.3]	25.6 [15.5, 39.4]	30.4 [18.7, 46.5]	31.7 [19.4, 48.4]

^aBreeder toms.

When considering the specific behaviours, behaviours such as wing flapping, wing/leg stretching and dustbathing need the most space for their simultaneous execution by all turkeys in a flock (Table 9). However, the proportion of the time budget taken up by these behaviours is relatively low in a flock (see Table 7). As such, on average, the largest proportion of space in a barn is used by the flock to perform stationary behaviours, followed by dynamic and other comfort behaviours (Figure 4).

TABLE 9 Minimum space allowance (cm²/turkey) resulting from the behavioural space model for hens and toms at different slaughter weights when 100% of the turkeys in a flock would be performing the same behaviour at the same time. Strutting only occurs in toms. Results are presented as median value, and 90% certainty interval is provided in square brackets.

Sex	Hens			Toms			
Slaughter weight	7 kg	12 kg	16 kg	16 kg	20 kg	Kg and more	> 25 kg ¹
Minimum space allowance for stationary behaviours (cm ² /turkey)	4006 [2455, 8223]	4643 [2961, 9081]	4954 [3189, 9532]	6426 [3953, 11,132]	6703 [4160, 11,536]	7023 [4396, 11,862]	7012 [4415, 11,893]
Minimum space allowance for dynamic behaviours (cm ² /turkey)	5180 [3415, 9816]	6044 [4114, 10,968]	6551 [4536, 11,670]	8379 [5520, 13,605]	8745 [5820, 14,074]	9166 [6162, 14,655]	9174 [6182, 14,620]
Minimum space allowance for other comfort behaviours (cm ² /turkey)	7773 [5553, 13,250]	9233 [6795, 15,146]	10,091 [7547, 16,235]	11,801 [8342, 17,913]	12,382 [8801, 18,592]	13,053 [9420, 19,387]	13,059 [9423, 19,489]
Minimum space allowance for wing flapping (cm ² /turkey)	9935 [7408, 16,050]	11,913 [9134, 18,587]	13,117 [10,163, 19,987]	14,693 [10,639, 21,618]	15,457 [11,266, 22,503]	16,383 [12,025, 23,632]	16,378 [11,999, 23,609]
Minimum space allowance for dustbathing (cm ² /turkey)	6599 [4578, 11,713]	7791 [5576, 13,313]	8492 [6159 to 14,207]	10,135 [6970 to 15,839]	10,603 [7376 to 16,413]	11,151 [7827 to 17,139]	11,181 [7839, 17,127]
Minimum space allowance for strutting (cm ² /turkey)	–	–	–	7846 [5073 to 12,950]	8187 [5366 to 13,345]	8562 [5672 to 13,878]	8654 [5686, 13,874]

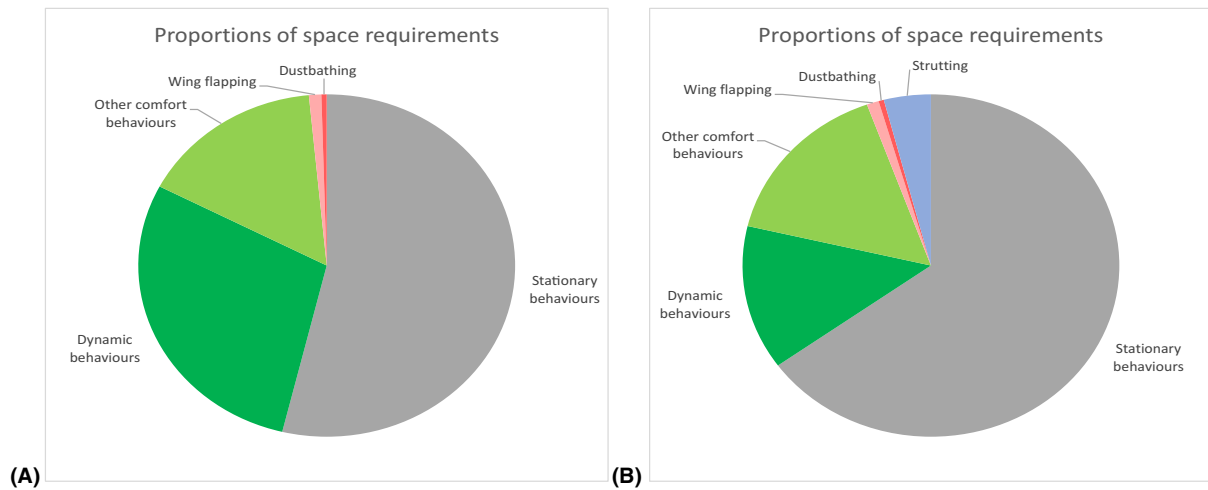


FIGURE 4 Proportion of space requirements (%) taken up at any given time by turkeys (A: Hens, B: Toms) performing classes of behaviour (stationary behaviours, dynamic behaviours, other comfort behaviours, wing flapping, dustbathing and strutting – toms only –) in a flock.

The uncertainty related to the behavioural space model is mainly caused by the estimation of the inter-individual distance (98%–99% of the uncertainty of the result is referable to the uncertainty of this parameter). Therefore, the relationship between inter-individual distance and stocking density (Figure 5A) and space allowance (Figure 5B) was plotted for the different slaughter weights of turkey hens and toms. When the inter-individual distance is nearly zero, turkeys can just perform the behaviour, but there is no space between the birds. For example, in order to allow the elicited inter-individual distance of 31.8 cm for hens, hens at 7 kg would need three times more space (4724 cm²/turkey) compared to when the inter-individual distance is set to 0 cm (1578 cm²/turkey Figure 5B). Alternatively, when keeping hens at a stocking density of 40 kg/m², hens of 7 kg slaughter weight would have approximately 3 cm of inter-individual distance available which is approximately 10 times less than the elicited 31.8 cm, which would be reached at a stocking density of 14.5 kg/m² (Figure 5A). The uncertainties of the behaviours were less than 1% (stationary behaviour was calculated as a residual). This highlights the need for more precise information on the inter-individual distance in turkeys. Once this is available, a second priority is to obtain more information on the time budget of dynamic behaviours, other comfort behaviours, wing flapping, dust bathing and strutting of turkeys in non-restricted environments to further reduce the uncertainty of the model.

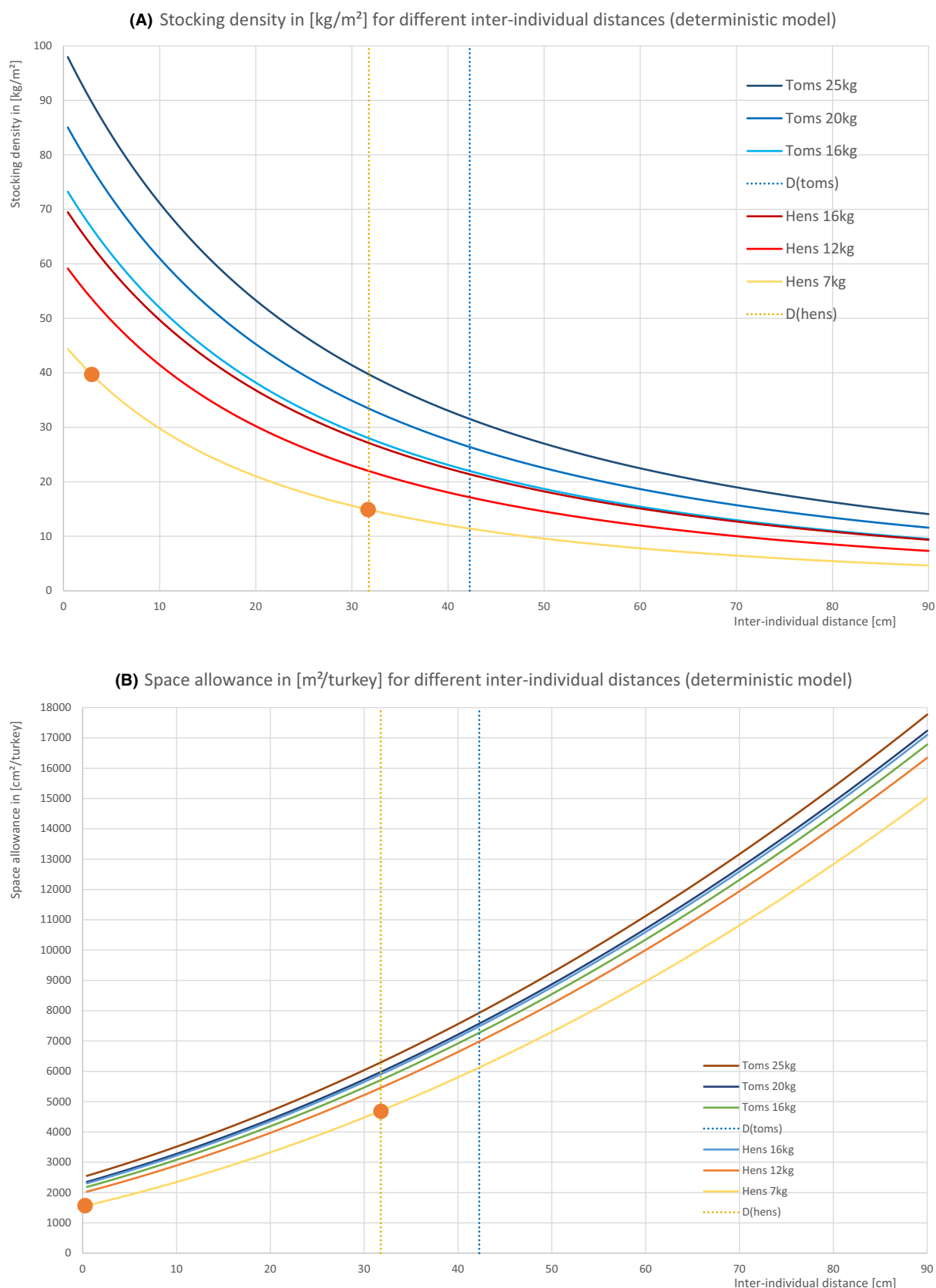


FIGURE 5 Relationship between inter-individual distance (cm) and (A) stocking density (kg/m²) and (B) space allowance (cm²/turkey) for hens and toms at different slaughter weights. The vertical dotted lines represent the elicited inter-individual distance (D) of hens (31.8 cm) and toms (42.3 cm). Orange dots represent the example from the text.

To further contextualise the outcomes of the behavioural space model, different scenarios are presented in [Table 10](#). The scenarios are based on hens of 12 kg and toms of 20 kg. Three scenarios are described. The first scenario describes the minimum space allowance to allow all turkeys in a flock to perform wing flapping (behaviour which requires the largest amount of space). It represents the scenario which requires the largest possible space requirement according to the behavioural space model. The second describes the minimum space allowance for when the turkeys perform the six behavioural

classes as per the time budget in the flock in the 75th percentile of the classes of behaviour. The third scenario describes the results of the behavioural space model where all turkeys in a flock can only perform stationary behaviours simultaneously (behaviour which requires the least amount of space according to the behavioural space model). Lastly, in scenario 4, national legislations are illustrated from two EU MSs – namely the Netherlands and Austria. The maximum stocking densities allowed under these conditions were converted to space allowance (assuming a 12 kg hen and 20 kg tom) for ease of comparison. It highlights that under the typically applied commercial stocking density, the space allowance provided is not sufficient for what is needed to allow turkeys to perform different behaviours. This discrepancy becomes clearer when space allowance needs not only to allow stationary behaviour but also accommodate different behavioural classes (which require more space) and take into account the time budget of different behavioural classes or the synchronisation between birds when performing behaviours.

TABLE 10 Different scenarios for turkeys for the space allowance per bird (cm²/bird) based on the behavioural space model in comparison to two national guidelines as an example.

Scenarios	Minimum space allowance in cm ² /bird (median, [90% certainty interval])	
	For hens of 12 kg	For toms of 20 kg
Scenario 1: All turkeys are performing wing flapping simultaneously The space allows 100% of turkeys to perform wing flapping and maintain inter-individual distance among birds	11,913 cm ² /hen [9134, 8587]	15,457 cm ² /tom [11,266, 22,503]
Scenario 2: All six behavioural classes are performed as per the time budget The space allows turkeys to perform the six behavioural class categories as per the time budget and maintain inter-individual distance among birds	5660 cm ² /hen [3791, 10,390]	7814 cm ² /tom [5073, 12,926]
Scenario 3: All turkeys are performing stationary behaviour simultaneously The space allows 100% of turkeys to perform stationary behaviours and maintain inter-individual distances among birds It will not allow dynamic, comfort behaviours, wing flapping, dustbathing or strutting	4643 cm ² /hen [2961, 9081]	6703 cm ² /tom [4160, 11,862]
Scenario 4^a: Current situation in commercial turkey farms Example of maximum stocking densities in commercial turkey farms. Based on stocking densities in national guidelines of the Netherlands (hens: 48 kg/m ² , toms: 58 kg/m ²) and Austria (hens and toms: 40 kg/m ²)	NL: 2500 cm ² /hen AU: 3000 cm ² /hen	NL: 3448 cm ² /tom AU: 5000 cm ² /tom

^aThe stocking density provided in national guidelines is converted to the space allowance provided per hen (12 kg) or tom (20 kg). No 90% certainty interval is provided for this modelled space allowance.

3.2.4 | Concentration of ammonia

3.2.4.1 | Background

Ammonia (NH₃) is a by-product of protein metabolism, naturally produced in poultry houses by chemical decomposition of uric acid by microorganisms present in the litter. The speed of this reaction is controlled by the uricase enzyme, which depends on the presence of water and oxygen as well as a litter pH between 8 and 9 (Mendonça et al., 2021).

3.2.4.2 | Hazards linked with concentration of ammonia and its associated welfare consequences

'Too high concentration of NH₃' in the ambient air leads to respiratory and eye disorders (Bist et al., 2023). Ammonia is also considered to be the main toxic gas linked to production loss in poultry (Bist et al., 2023). For instance, NH₃ levels above 25 ppm inside poultry houses have been reported to negatively affect broiler chicken growth performance, including reduced body weight gain, feed intake and feed conversion rates (Miles et al., 2004; Zhou et al., 2020). Moreover, a study conducted by Amer et al. (2004) where laying hens were exposed to 100 ppm NH₃ for 4 weeks led to reduced feed and water intake, decreased body weight gain, fewer eggs and reduced egg weight and egg mass. Furthermore, Schäfers et al. (2024) reported an increase in agonistic behaviour with high NH₃ concentrations.

In turkey poults, levels of NH₃ in the ambient air as low as 10 ppm have been shown to irritate the lining of the respiratory tract and increase susceptibility to disease-causing agents (Poss, 1998). Being absorbed into the circulatory system, NH₃ decreases the monocytes' ability to engulf and destroy bacteria in the blood stream. This leads to significantly reduced immunological response to *E. coli* infections, a primary contributor to respiratory diseases in poultry (Poss, 1998). This conclusion was based on the results of Nagaraja et al. (1984), where turkeys exposed to 10 and 40 ppm NH₃ and subsequently challenged with *E. coli* showed more germs in their lungs than their counterparts that were not exposed to NH₃. Moreover, prolonged exposure of turkeys to 10 or 40 ppm NH₃ led to a deterioration of the mucociliary apparatus evidenced by excessive mucous production, loss of tracheal cilia and histological alterations to the tracheal epithelium (Nagaraja et al., 1983). Hence, levels of NH₃ in the air as low as 10 ppm, which are not detectable by the olfactory system of humans (Poss, 1998),

have been shown to have negative health effects on turkeys. Ammonia has also been suggested to contribute to air sacculitis, a lower respiratory tract disease in turkeys defined as inflammation of one or more of the air sacs leading to carcass condemnation at the slaughterhouse. Indeed, a study investigating the causes of air sacculitis in toms showed that high aerial concentrations of *Aspergillus* spores, NH_3 , dust and aerosols were concurrent with high mortality rates among turkeys raised under commercial conditions (Janni et al., 1985). As previously mentioned, elevated NH_3 concentrations reduce immunological responses of turkeys. Members of *Aspergillus* species, like some bacterial and viral infections, are opportunists that take advantage of birds whose immunological defences have been weakened by other health problems (Femenia et al., 2007), causing further weakening or even death. Such respiratory issues and weakened immune system may explain the reduced growth performance reported in turkeys kept under high concentrations of NH_3 (e.g. Zuidhof et al., 1993).

Excessive moisture in the litter leads to the formation of NH_3 (Cai et al., 2006). Abd El-Wahab et al. (2012) reported much lower levels of NH_3 (0.7 ppm with a relative humidity of 14.5%) in dry litter as compared to wet litter treatments in turkeys (7.18/8.08; 9.13/10.4 and 11.0/12.0 ppm for 35%, 50% and 65% moisture for 4 or 8 h of exposure, respectively). Thus, elevated NH_3 levels can be dissolved in high moisture litter, forming an irritating alkaline solution that contributes to the development of FPD (Tucker & Walker, 1992). FPD However, such a link could not be clearly established in studies performed with fattening turkeys, where the results indicated that the concentration of NH_3 and/or uric acid in the litter did not worsen the harmful effects of moisture on footpads (Youssef et al., 2008). A study was conducted by Youssef et al. (2011) on female turkeys over a period of 3 weeks to assess the effects of water alone, NH_4Cl or uric acid as end products of protein metabolism, independent of the presence of excreta, on the development and severity of footpad dermatitis. The control group was continuously kept in its pen, while the other groups were moved for 8 h daily to adjacent separate boxes, enriched with water alone or water with NH_4Cl or uric acid. Their results showed no negative effects of NH_3 and uric acid on footpad lesions, indicating that the high moisture alone in the litter is sufficient to cause FPD in young turkeys (Youssef et al., 2011). These results also suggest high litter moisture to be the most likely factor causing FPD in turkeys. However, a conclusion on the influence of NH_3 on FPD in turkeys cannot be drawn based only on the results of these two studies. More studies are still needed to understand the contribution of NH_3 on the occurrence of the multifactorial issue of FPD in turkeys and possibly on the occurrence of other skin lesions.

Low space allowance may also increase the NH_3 concentration as the bird stocking density affects the manure accumulation per unit of surface area, which may then affect NH_3 emission (Mendes et al., 2012). This is supported by results obtained from studies of broiler chickens (Abouelenien et al., 2016; Zhang et al., 2011) and laying hens (Mendes et al., 2012). For instance, increasing the stocking density of broilers from 10 to 20 birds/ m^2 resulted in an increase of NH_3 emission from 3.5 to 20.28–31.4 mg/L at 28–36 days of age (Abouelenien et al., 2016).

Brink, Janssens, Demeyer, et al. (2022b) reported a complex relationship between the type of bedding material, litter conditions, moisture content, FPD and volatilised NH_3 in broilers. They suggested that bedding materials which develop a crust at the top of the litter layer throughout the rearing period may reduce NH_3 emissions, although caking was not measured under the conditions of their study. This suggestion agrees with other studies (i.e. Miles et al., 2008, 2011) indicating that the compaction may create a less aerobic litter environment, reducing the pH and increasing the ionised fraction (NH_4) while reducing the un-ionised fraction (NH_3) of total ammoniacal nitrogen. The results of Brink, Janssens, Demeyer, et al. (2022b) also showed that although the lower litter quality characterised by crust formation and caking created the lowest risk for NH_3 release from the litter, it negatively affected broiler welfare by increasing the incidence of FPD. However, better litter quality (without crust formation and caking) with beneficial effects on broiler performance and welfare may contribute to higher NH_3 volatilised from the litter. Thus, management practices should be adjusted to each bedding material to ensure bird welfare while reducing NH_3 emissions.

The recommended maximum thresholds of NH_3 concentration vary across organisations. The recommendation from Hendrix Genetics is to maintain the NH_3 concentration below 25 ppm in turkey barns (Hybrid, online-b), whereas Aviagen recommends to maintain this value below 20 ppm (Aviagen Turkeys, 2024). The RSPCA standards recommend that for turkeys of 14 days of age or younger NH_3 levels should not exceed 10 ppm at bird head height, and for birds of 15 days or older, the ammonia levels should not exceed 15 ppm at the height of the birds' head (RSPCA, 2020). According to RSPCA welfare standard of turkeys in UK, NH_3 should be kept below 5 ppm at all times (RSPCA, 2020). EFSA has recommended species-specific guidance: for broilers, NH_3 should remain below 15 ppm and for laying hens, below 10 ppm. The guidelines of Germany for turkey farming indicates that NH_3 levels should not exceed 20 ppm (Verband Deutscher Putenerzeuger, 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Landwirtschaftskammer Nordrhein-Westfalen). More detailed thresholds would be desirable but are not available currently.

Liu et al. (2021) showed in broilers that head shaking correlates significantly with increased NH_3 concentration. Compared to an NH_3 concentration of 0 ppm, chickens increased head shaking events significantly at 15 ppm, while losses in performance were only visible at the highest NH_3 concentration investigated. The higher the NH_3 concentration, the more times the broilers shook their heads. The increase in NH_3 concentration also reduced average daily feed intake, average daily gain and feed/gain.

3.2.4.3 | Preventive measures

Preventive strategies for reducing NH_3 emission among other air pollutants include mainly two approaches: initiatives taken pre-excretion (i.e. reduction at the source before manure is produced, e.g. diet manipulation and feed additive) and pre-release (i.e. removal from the flow of gases before dispersing in the environment, e.g. litter additives, management

including ventilation and housing design) (Chai, Xin, et al., 2018a; Chai, Zhao, et al., 2018b; Ni, 2015; Ritz et al., 2004). Regarding pre-excretion, diet composition including dietary protein levels and electrolyte balance, among others, can affect the consistency of droppings, which in turn can have an impact on NH_3 emission (Oviedo-Rondón et al., 2001; Smith et al., 2000). Therefore, minimising excess crude proteins in diets, reducing calcium and phosphorous amounts added to commercial feeds, as well as proper formulation of sodium and chloride, may help to reduce ammonia emission. Other preventive measures for reducing NH_3 emission are ensuring a good flock health and good dropping quality by providing sanitised water and balanced diets (Nahm, 2007).

Maintaining dry litter condition helps to reduce NH_3 volatilisation, improving air quality and bird health. This can be achieved through proper ventilation and airflow, ensuring an adequate relative humidity and the removal of moisture excess. During cold weather conditions, ventilation might be reduced, increasing the risk of too high concentration of NH_3 . For laying hen houses, Mendes et al. (2012) reported low space allowance (155 cm^2 per bird; high stocking density) to have 51% higher NH_3 emissions (mg/bird/day) as compared to high space allowance (206 cm^2 per bird; low stocking density) for 4- to 5-week-old pullets and to average 22% higher NH_3 emission for laying hens kept at low space allowance (413 cm^2 per bird; high stocking density) as compared to those kept at high space allowance (620 cm^2 per bird; low stocking density).

The use of drinking systems without spillage and mechanical ventilation (EFSA AHAW Panel, 2023a) as well as circulation fans for air extraction and floor heating is reported to maintain the litter moisture below 30% (Mayne, Else, & Hocking, 2007; Wu & Hocking, 2011).

3.2.4.4 | Mitigation measures

Mitigation measures are mainly focused on increased ventilation and re-littering (EFSA AHAW Panel, 2023a) to maintain both litter quality and sufficient bedding depth allowing proper moisture absorption (see Section 3.2.1).

3.2.5 | Concentration of carbon dioxide

3.2.5.1 | Background

Carbon dioxide (CO_2) is one of the most important gases resulting from turkey production generated primarily from bird respiration and the microbial degradation of uric acid in manure (microbes break down uric acid and other nitrogenous compounds, releasing CO_2 and sometimes other gases like NH_3). Additional CO_2 is also produced inside the facilities by un-vented conventional propane-fuelled heaters in addition to water vapour and carbon monoxide (Olanrewaju et al., 2008; Reece & Lott, 1980). Thus, the CO_2 concentration inside poultry facilities may be affected by several factors including the litter condition, manure handling and type of heater used (Calvet et al., 2011; Xin et al., 2009), bird respiration, ventilation rate, the number of birds in the barn, stocking density, bird age, activity level, feed intake and diet composition (Calvet et al., 2011; Pedersen et al., 2008).

3.2.5.2 | Hazards linked with concentration of CO_2 and its associated welfare consequences

Being heavier than air, CO_2 accumulates at the bird level and reduces the O_2 concentration (Cândido et al., 2018). A competition for binding haemoglobin between CO_2 and O_2 may occur contributing to hypercapnic hypoxia (Olanrewaju et al., 2008). Hypoxia may lead to right ventricular hypertrophy and eventually result in ventricular failure (Julian et al., 1992), and is proposed to be one of the causes of cardiomyopathy in poultry (Owen et al., 1995).

The typical CO_2 concentrations in turkey barns under normal ventilation conditions are generally in the range of 2000 to 3000 ppm, rising above 4000 ppm under low ventilation conditions, especially during cold weather when airflow is reduced to conserve heat (Chepete et al., 2012; Noll et al., 1997). It has been shown that exposure to 4000 and 6000 ppm CO_2 compared to 2000 ppm CO_2 alter the behaviour of turkey tom poults, causing increased movement suggesting an attempt to avoid exposure to these higher levels of CO_2 (Cândido et al., 2018). Furthermore, Cândido et al. (2018) showed that the poults exposed to 4000 and 6000 ppm CO_2 had a reduced cumulative and week 3 weight gain compared to those exposed to 2000 ppm CO_2 . Hypercapnia, referring to an elevated concentration of CO_2 in the air, has been reported to be a stressor and hence a risk factor for early poult mortality (Donaldson et al., 1995). Indeed, exposing turkey poults to breathing air containing 4000 ppm CO_2 for 16 h post-hatch resulted in altered metabolism (i.e. depleted glycogen reserves, lower hepatic glucose-6-phosphatase activity, higher renal PEPC activity, elevated plasma T4 and lower PO_2 in venous blood) (Donaldson et al., 1995).

The EU legislation (Council Directive 2007/43/EC) for broiler chickens and the guidelines on turkey farming in Germany require that CO_2 should be maintained under 3000 ppm (Verband Deutscher Putenerzeuger, 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Landwirtschaftskammer Nordrhein-Westfalen). Mailyan and van Schie (2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung) indicated the optimal CO_2 level to be below 2500 ppm regardless of the age of turkeys and the season, but does not argument how this threshold was obtained.

3.2.5.3 | Preventive measures

Increased CO₂ concentrations can be prevented by ensuring adequate ventilation rates (Noll et al., 1997). This may be achieved by using ventilation systems which are well-maintained and optimised for the size of the unit as well as for the climate zone where the facility is located. Inefficient ventilation and heating may occur when temperature and humidity sensors are poorly positioned or defective, indicating the importance of keeping the sensors functional and positioned at the bird head height.

3.2.5.4 | Mitigation measures

As also recommended by EFSA for broilers, the main mitigation measure is mainly focused on increased ventilation (EFSA AHAW Panel, 2023a).

3.2.6 | Effective environmental temperature

3.2.6.1 | Background

The effective environmental temperature (hereafter referred to as temperature) is mainly determined by the combination of air temperature and humidity (EFSA AHAW Panel, 2022a). Satisfying the thermal comfort needs of turkeys require heating and ventilation systems (and in special cases cooling systems) to ensure an optimal temperature and relative humidity throughout the entire period of housing (Kartzfeln, 2021; VKM, 2016).

3.2.6.2 | Hazards linked with effective environmental temperature and associated welfare consequences

The hazards linked to the factor temperature are 'too high temperature' and 'too low temperature'. When turkeys are subjected to 'too high temperature', they experience Heat stress, whereas 'too low temperature' leads to Cold stress. Heat/Cold stress may occur during the incubation period, in the hatchery, on the farm, as well as during transport to and from the farm (Julian, 2005). Turkeys are homeotherms, i.e. they can maintain their body temperature within a small range (Yahav, 2001). However, during the first 5–7 days, turkey poults are initially closer to poikilotherms and cannot fully regulate their body temperature, which will vary in line with the temperature of the environment (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). 'Too high' or 'too low temperatures' during the first week of life will have a negative effect on the poults' activity, uniformity, daily growth, liveability and final body weight (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). For poults, a relative humidity of 50–60% is usually recommended. The thermoneutral zone (TNZ) is the range of ambient temperatures within which metabolic rate is at a minimum, and temperature regulation is achieved by non-evaporative physical processes alone (EFSA AHAW Panel, 2022a).

Optimal growth is achieved when the animals are raised within the TNZ (Mayes et al., 2015). This is because they are expending the least amount of energy for basal and maintenance activities, such as thermoregulation. In young poults, the optimal ambient temperature has been reported as 29.4°C by Xin et al. (1998), while Hall and Menges (2012) stated that the TNZ for adult turkeys ranges from 13°C to 24°C. The variability in the TNZ at different ages is due to the fact that turkeys' thermoregulatory abilities (Weytjens et al., 1999) and metabolic rates (Xin et al., 1998) change with age.

From a welfare point of view, turkeys should be kept in their thermal comfort zone (TCZ), where neither higher metabolic rate nor animal behaviour is activated in any way to keep body temperature within the normal range (SO transport in containers, EFSA AHAW Panel, 2022a).

Too low environmental effective temperature.

Poultry exchange heat by conduction, convection, radiation and evaporation. Heat exchange via radiation can be a major contributor to Cold stress because in very cold weather conditions heat can radiate from turkey's body to the environment. Furthermore, unsuitable (too high) ventilation rates could increase convective heat loss as well as surface evaporative cooling if the weather is cold (EFSA AHAW Panel, 2023a). Poults experiencing cold stress at the time of placement will clump together, have a delayed initial feed and water intake, increased risk of mortality and poor body weight uniformity (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). Ten percent of poults that have a body temperature of 37°C and lower upon placement on farm have been shown to die shortly thereafter (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). Older turkeys can better regulate their body temperature but may still suffer from Cold stress in case of e.g. outdoor housing during winter. If experiencing Cold stress, turkeys, regardless of age, will show huddling to reduce temperature loss and their cloacal temperature will fall below normal range. On arrival and 12 h after placing, the body temperature of the poults should be between 39.5°C and 40°C (Hybrid, online-a).

Mendes et al. (2020) evaluated the effect of seven different combinations of temperature, relative air humidity and air speed on the frequency and duration of several behaviours, including resting, cannibalism, dustbathing, foraging and shivering, of turkeys at three different ages. The seven combinations (applied 5 days) tested were: 1 (22°C, 50%, 1 m/s), 2 (26.2°C, 73.2%, 0.45 m/s), 3 (26.6°C, 71.2%, 1 m/s), 4 (28.9°C, 72%, 1.4 m/s), 5 (31.1°C, 85%, 0.45 m/s), 6 (34.1°C, 82.1%, 1 m/s) and 7 (34.4°C, 82.1%, 1.4 m/s) for three ages of birds (61, 96 and 131 days of age, toms, unknown genotype). The results showed that young birds were more likely to suffer from the combination of low temperature and high air speed, reducing their frequency of normal behaviours. Increased humidity at a low temperature increased the frequency of scratching, shivering and cannibalistic behaviour leading to poorer bird welfare. The authors recommended that the temperature, relative air humidity and air speed combination of 26.6°C, 71.2% and 1 m/s, for young birds of 61 days and 22°C, 50% and 1 m/s for older birds (e.g. 131 days) should be used.

Too high environmental effective temperature

At high relative humidity and high temperatures, birds have problems reducing excess heat. In extreme situations, such as a prolonged time at 85% relative humidity and 35°C, mortality may occur (Maillyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). There are two measures used for assessing Heat stress. One is to use the enthalpy values or the energy content of the air, calculated as the specific enthalpy (kJ/kg), which focusses on the fact that enthalpy of moist air is an important factor that impact the body temperature of birds (Sake et al., 2024). The higher the humidity at the same temperature, the higher the enthalpy. Enthalpy values ≥ 67 kJ/kg in the outer air may cause severe (67 to < 72 kJ/kg) or extreme (> 72 kJ/kg) Heat stress (Sake et al., 2024). Another recognised measurement method to assess the TCZ is using the temperature-humidity index (THI), which takes into account relative humidity and temperature and represent a recognised indicator to assess the TCZ. De Moraes et al. (2008) developed a THI classification for poultry which varies from absolute comfort (≤ 72) up to a value of ≥ 85 (life threatening), with the note that turkeys are in severe discomfort when THI reaches values of ≥ 81 . However, it is unclear on which basis classification was made in regards to bird comfort. Sake et al. (2024) compared both measurements using as thresholds for enthalpy (≥ 67 kJ/kg) and THI (≥ 81) and concluded that the occurrence of these values in ambient air probably cause severe Heat stress. Furthermore, the authors mentioned that Heat stress in turkeys can also occur at lower values. Brown-Brandl et al. (1997a) investigated different temperature-humidity combinations (23°C–40°C, 40%–90% RH) to develop a THI for growing tom turkeys. They used four different ages (6, 10, 15 and 20 weeks) taking into account different parameters such as core body (cloacal) temperature. They found a range from 40.85°C (week 6 and 10; temperature 25°C; relative humidity 56%) over 42.12°C (week 15) up to 40.03 (week 20) at 25°C and 60% relative humidity for the latter two ages. At 6 weeks of age, temperature and humidity showed to have nearly the same effect on their physiological stress levels, while after 10 weeks of age, relative humidity appeared to have a greater influence.

Panting in turkeys is an indicator of 'too high temperature' and may begin below 24°C depending on age and relative humidity (Menges, 2024). Generally, temperature thresholds to prevent either Cold or Heat stress cannot be established as they depend on several factors including humidity, body weight, stocking density, age and hybrid, degree of adaptation and duration of exposure (EFSA AHAW Panel, 2023a).

Heat stress may occur in turkeys kept in indoor systems, especially at high stocking density, where it is harder for turkeys to dissipate heat. Turkeys may respond to Heat stress with decreased feed intake as well as increased water consumption and higher respiration rate (Brown-Brandl et al., 1997a). The body temperature may increase, and turkeys can become dehydrated at different high temperature–humidity combinations. This can occur at all ages (Brown-Brandl et al., 1997b; Jankowski et al., 2015). Heat stress is reported to be better tolerated in turkeys younger than 5 weeks (Jankowski et al., 2015). Moreover, older turkeys and especially modern genotypes are reported to be more susceptible to Heat stress than older genetic lines because of their higher metabolic rates and the elevated energy content of their diets (Farghly et al., 2018; Havenstein et al., 2007; Uemura et al., 2023). Most of the bird's heat load is the result of metabolic heat coming from digestion, absorption and nutrient assimilation or excretion (Farghly et al., 2018).

Air velocity depends on different ventilation parameters. Capacity of the ventilation system and positioning of the ventilation inlets are important parameters to achieve good ventilation and correct indoor temperature of the barn (RSPCA, 2023). A survey (EFSA, 2026) showed that various ventilation types are used in turkey houses in the different EU member states, including natural, mechanical and mixed ventilation.

Regarding natural ventilation, the differences between indoor and outside temperature and pressure induce air flow, which is aided by fans inside the barn (Uemura et al., 2023). Mechanical ventilation is provided by strategically placed fans as either tunnel (longitudinal) or cross (sidewall) ventilation (Shah et al., 2013). In tunnel-ventilated houses, fresh air entering through large openings at one end replaces the stale air which is exhausted by fans at the opposite end of the house. The high airspeeds ($\geq 3 \text{ m} \cdot \text{s}^{-1}$) generated by the large volumes of air travelling along the length of the house cool the birds. Fans on the sidewall of sidewall-ventilated houses push fresh air into or pull exhaust air from the house, with the opposite screened wall serving as an outlet/inlet, producing much lower average airspeeds than tunnel-ventilated houses ($< 1 \text{ m} \cdot \text{s}^{-1}$) (Bustamante et al., 2013) even with the same ventilation rate ($\text{m}^3 \times \text{min}^{-1} \times \text{kg}^{-1}$). This lower airspeed of sidewall ventilation is due to the lateral air movement across a much larger cross-sectional area compared to the longitudinal air movement across a much smaller cross-sectional area in the tunnel-ventilated houses. All these factors should be taken into account to ensure good ventilation, allowing a thermally comfortable environment for turkeys regardless of the type of ventilation.

It is possible to use air velocity to cool birds even at higher ambient temperatures, but above 38°C this wind chill effect is not effective anymore (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). The cooling effect of air velocity increases significantly at low temperatures, high humidity and high air speed. Cooling and management can reduce the temperature in the barn but only to a certain degree, these capacities are limited (Raza et al., 2020). In this context, Yahav et al. (2008) conducted a study to elucidate the effects of different rates of air speed on young turkeys' (B.U.T. toms, 3–6 weeks of age) performance during exposure to temperatures being kept constantly at 35, 30 and 25°C, respectively. Turkeys exposed to 35°C at an air speed of 2 m/s exhibited significantly higher feed intake and significantly lower body temperature than turkeys subjected to lower air speed. At 30°C, performance was optimal at an air speed of 1.5 to 2.5 m/s and significantly lower at 0.8 m/s. Performance of turkeys exposed to 25°C did not vary with air speed. The authors concluded that air speed affects the performance of young turkeys and that the higher the temperature, the higher the air velocity needed (Yahav et al., 2008). The combination of 30°C with air speed from 1.5 to 2.5 m/s was optimal for the growing performances of young turkeys of that genotype and age.

Uemura et al. (2023) performed chamber and room studies to evaluate the effect of Heat stress at moderate temperatures (<25°C) and low airspeeds on grown turkey toms of Large White, Nicholas Select genotype (13 to 19-week old for the chamber study and 21-week old for the room study). Their results showed that Heat stress was reduced by the higher ventilation rates, and this was due to lower room temperatures and not airspeed differences, which were very low (Uemura et al., 2023).

3.2.6.3 | Preventive measures

To prevent the temperature in the barn from being outside the TCZ for turkeys, which depends on turkey age and genotype, heating and ventilation systems need to be adjusted to reach the target temperature. Appropriate temperature management ensures that turkeys have access to a thermally comfortable environment throughout the whole production cycle. This starts by heating the barns several days before poults arrival. Breeding companies provide genotype-specific guidelines for temperature management. For instance, Aviagen Turkeys recommends 37°C during the first day, which should be decreased by 1°C per day during the first week (Aviagen Turkeys, 2024). This is done to avoid Cold stress, since poults are incapable of proper thermoregulation during their first week of life (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). Slight differences are reported by Hendrix Genetics for the genotype Hybrids. They recommend 35°C which should be decreased to 31°C by day 7 (Hendrix, online). Cold stress in poults is prevented by controlling the temperature by pre-heating and heating the barn and preventing currents of cool air in the barn (draughts).

Following the first week of life, a gradual decrease is applied to reach recommended temperature values such as 22–23°C by week 10 (Aviagen, Hybrids) and then 16–17°C from week 10 until the end (Aviagen Turkeys, 2024).

Another measure for preventing Heat stress is the installation of pad cooling systems, which helps to decrease the temperature of air entering the barn and improves the thermal comfort of the turkeys (EFSA AHAW Panel, 2023a), especially in regions that regularly reach high temperature in the summer. Air from outside passes through a layer of wet pads into the barn (EURCAW Poultry SFA, 2024a). This makes the air more humid and cooler since humid air contains more thermal energy than air of the same temperature with lower humidity. The lower the outdoor humidity, the more effective the cooling pads are, i.e. the evaporative cooling principle works especially well in hot and dry environments.

Other systems such as foggers or mist sprays can also be used in regions that reach high temperatures less frequent (Hendrix, online). Reducing the stocking density can also lead to decreased heat accumulation in barns and, thus, decreased risk of Heat stress (Jankowski et al., 2015). Published welfare standards of turkeys (e.g. RSPCA, 2023) detail the importance of shade and shelter to avoid Heat stress in birds with access to an outdoor range.

Although no information is available for turkeys, provision of elevated structures may be a preventive strategy to alleviate Heat stress based on results obtained with other meat-producing poultry species. Indeed, broiler chickens (*Gallus gallus domesticus*) may face difficulty dissipating heat from the body when sitting on the litter (EFSA AHAW Panel, 2023a) and thus elevated structures and perches may improve heat dissipation by offering the birds the possibility to escape from the litter (Gebhardt-Henrich et al., 2017). Elevated structures with a cooling functionality may further alleviate Heat stress (Khalfi et al., 2024). The expert opinion is that it is likely that provision of elevated structures for turkeys can also play a role in the prevention or mitigation of Heat stress. However, the effectiveness may depend on the placement of the elevated structures in the barn in relation to the ventilation flow.

3.2.6.4 | Mitigation measures

Ventilation is a mitigation measure allowing alleviation of Heat stress in turkeys (Uemura et al., 2023).

3.2.7 | Group size

3.2.7.1 | Background

Group size could play a role in turkey welfare, but it has received relatively limited scientific attention due to practical research constraints, and therefore, research specifically linking variations in group size to welfare consequences remains

scarce. In contrast to the link between space allowance (stocking density) and different welfare consequences, which is supported by literature (see Section 3.2.3), the link between maximum group size and welfare consequences is much less clear (see Section 3.2.7.1). Furthermore, the group size effect is often confounded with total space allowance, making its isolated effects difficult to assess (Leone & Estevez, 2008).

In scientific literature, the term group size often refers to the number of birds within a defined social group in an experimental context, whereas flock size describes the total number of birds in a commercial unit or barn. Experimental studies investigating turkey welfare often utilise small group sizes within pens designed to allow observation and control over social interactions. For example, Moran (1985) conducted studies with group sizes of 15 to 120 birds, assigning space allowances ranging from 0.077 to 0.89 m²/bird based on the number of birds per pen. These values were fixed for each group and not adjusted according to the age or growth stage of the animals. Similarly, Noll et al. (1991) worked with groups of 13 to 28 turkeys, while Martrenchar et al. (1999) examined groups of 317 to 540 birds to evaluate welfare outcomes in different environments. Conversely, on-farm studies deal with much larger flock sizes. A study in Canada by van Staaveren et al. (2020) found the median flock size at placement was 6715 birds, with some farms housing groups over 11,000 turkeys. Marchewka et al. (2015) reported commercial flocks in the USA ranging between 6460 and 8462 birds. In a set of industry-based studies conducted in 2019–2021 in Norway, flock sizes ranged from approximately 2250 to 11,200 birds (Marchewka et al., 2019, 2020; Vasdal et al., 2021). A recent study in Germany investigated 11 turkey conventional and organic farms between 2000 and 25,200 turkeys (Michaelis et al., 2024). These large numbers reflect commercial standards and production efficiency goals, but they pose challenges for evaluating welfare indicators of the individuals or the whole flock.

After hatching, poults are often placed in brooding pens to ensure they find feed and water easily in a warm environment. Poults are placed into small circular brooding pens for the initial days (ranging between 2.5 and 4.5 m) diameter with a group size of up to 400 poults (Berk, 2020). After 5 to 7 days these pens are removed, allowing the birds access to the entire rearing barn, which may contain tens of thousands of birds.

Breeder farms maintain separate flocks of hens and toms. The size of the breeder flocks can vary, but is generally smaller than meat production flocks to ensure proper management and genetic diversity (EFSA, 2026). Specific numbers can vary based on the breeding programme, the level of the flock in the generations pyramid: pedigree, great-grandparents, grandparents, breeders and farm capacity.

In conventional turkey production, there are generally no legal limits on flock or group size in most countries, including the United States and Member States of the European Union. Instead, management practices are typically driven by industry standards, welfare guidelines and economics rather than strict regulation. Under the EU Organic Regulation (e.g. EC 2018/848), there are specific provisions for turkeys. These include a maximum flock size of 2500 turkeys. Guidelines emphasise that larger flocks require a higher degree of skill and conscientiousness from stockmen to ensure the welfare of individual birds. According to the UK's Code of Recommendations for the Welfare of Livestock—Turkeys, successful management of large flocks depends heavily on the competence and carefulness of the handlers, as welfare risks can increase with group size (DEFRA, 2020). Thus, appropriate management practices become critically important in maintaining welfare standards in larger flock systems.

In the management guidelines from major turkey breeding companies such as Aviagen Turkeys and Hybrid Turkeys, there is no explicit mentioning of specific flock or group size recommendations for commercial turkey production.

While not all certification schemes specify maximum flock sizes, organisations like the Royal Society for the Prevention of Cruelty to Animals (RSPCA) and the Soil Association, a UK-based organic certification body, have implemented such limits to enhance turkey welfare. RSPCA provides detailed welfare standards for turkeys. While they do not specify a maximum flock size for indoor or standard free-range systems, they set a limit for traditional free-range systems, allowing a maximum of 2500 turkeys per house. In the RSPCA welfare standards, standard free-range typically refers to systems where turkeys have access to outdoor space during the day but may be kept in larger flocks with less emphasis on traditional management practices. In contrast, traditional free-range systems are more restrictive in terms of flock size and often use slower-growing breeds, longer rearing periods and different rearing conditions that favour higher welfare outcomes. This limit in flock size aims to facilitate better stockmanship and thorough flock inspections, ensuring individual bird welfare. The Soil Association stipulates that for organic production, the maximum flock size is 1000 turkeys (Soil Association, 2023). This standard reflects the association's belief that this allows for better oversight and reduced Group stress among birds, and thus higher welfare conditions.

The standards listed above reflect the assumptions of the individual organisations that smaller group sizes will lead to improved welfare, while it is not clear on which scientific evidence they base these recommended group sizes.

3.2.7.2 | *Hazards linked with group size and its associated welfare consequences*

As farmed turkeys are always kept in groups, the potential hazard regarding the factor group size is 'too large group size'. In the reviewed literature discussing group size effects on behaviour and welfare of domestic turkeys, references to the social behaviour of wild turkeys are common, particularly their tendency to form stable, kin-based groups (Balph et al., 1979; Healy, 1992). However, as noted by Kiani (2022), it remains uncertain whether such patterns can be applied to commercially reared turkeys.

The links between group size and welfare consequences reported in the literature refer mainly to turkey behaviour, including Group stress leading to Soft tissue lesions and integument damage as a consequence of injurious pecking and agonistic interactions other than pecking.

The limited available research suggests that group size may influence Group stress through aggression and impaired social recognition. However, findings from small experimental groups are not directly applicable to large commercial groups, where aggression and hindered social recognition are more likely to occur (Buchwalder & Huber-Eicher, 2003, 2005). Buchwalder and Huber-Eicher (2005) demonstrated that 8-week-old turkey toms reared in small groups (6 birds) exhibited significantly more aggressive behaviour when an unfamiliar conspecific was introduced compared to 8-week-old turkey toms reared in larger groups (30 birds). Birds in smaller groups initiated more fights and delivered more aggressive pecks. This pattern was also observed in the behaviour of the introduced bird: turkeys originating from small groups displayed more aggression toward unfamiliar group members than those from larger groups. The explanation offered hinges on recognition capacity. It is suggested that 30 birds may exceed the upper threshold of individual recognition for turkeys. Above this limit, individual identification is lost, which likely dampens the incentive for establishing dominance hierarchies. In wild turkeys, stable hierarchies are formed within close kin groups (Buchholz, 1997; Healy, 1992), but in commercial settings, flocks exceed this recognition limit. As a result, efforts to establish hierarchies may fail or result in chronic low-level aggression without clear dominance relationships (Pagel & Dawkins, 1997).

Small groups of familiar toms seem to be able to distinguish nongroup members toward whom they display aggressive interactions, but the frequency of interactions appears to be modulated by enclosure size (Buchwalder & Huber-Eicher, 2004). Buchwalder and Huber-Eicher (2004) found that in groups of 6 turkey toms (8 weeks old) per pen reared in smaller pens (2 × 3 m), more aggressive pecks occurred during introductions of unfamiliar birds, compared to the same groups in larger pens (6 × 13 m). This suggests that spatial restrictions in small groups may prevent avoidance behaviours, increasing conflict frequency. The concept of critical distance becomes relevant where, without sufficient space to avoid antagonists, aggression escalates. Critical distance was defined by Hediger (1961) as the minimum spatial buffer required to prevent conflict between individuals in a social group.

The applicability of the above findings focused on experimental conditions with small group sizes may not be comparable to the large-scale commercial systems, where turkeys are often kept in flocks of several thousands (Marchewka et al., 2015; van Staaveren et al., 2020). At present, there are no published studies directly comparing turkey welfare in small group sizes to those used in commercial production settings. This gap in the literature is likely due to a combination of practical and methodological constraints, including the logistical complexity of conducting controlled experiments at a commercial scale, and the difficulty of isolating group size as a single variable without confounding factors such as housing design, genetics or management practices. Moreover, collecting sufficient sample size of uniform, commercial-size flocks would be very costly, as for such type of studies one commercial flock would be considered an experimental unit. Filling this knowledge gap would be crucial for informing evidence-based guidelines on optimal group sizes, and could help refine welfare standards to ensure they are grounded in robust, scalable research. Based on the available research, it is not possible to determine the maximum group sizes that prevents Group stress.

Although there is no scientific evidence to define a specific threshold for group size in turkeys, EFSA experts have concluded that larger flock sizes may impede effective welfare inspection and monitoring. This is due not only to practical challenges such as reduced visibility, high animal density and difficulty in identifying individual birds requiring attention, but also to the increased labour investment due to relative more working hours of the personnel needed to inspect such flocks. These constraints can compromise the assessment of animal-based measures related to specific welfare consequences. Therefore, it is important to implement robust and scalable flock monitoring protocols. One such protocol is the transect walks method, consisting of an observer walking predetermined paths through a turkey flock to record welfare indicators, which has been scientifically validated for on-farm welfare assessment in turkey flocks of up to 8462 birds (Marchewka et al., 2015). Marchewka et al. (2015) demonstrated that this method yields results comparable to individual assessments during load-out, enabling full-house evaluations in a time-efficient manner without handling birds and making it a practical and reliable tool for welfare monitoring in relatively large turkey flocks.

3.2.7.3 | Preventive measures

Under the assumption that too large group size is a hazard, the following measures would prevent Group stress. In conventional turkey production systems, where flocks typically range from several thousands to over 10,000 birds, it is not feasible to reduce group sizes within the recognition capacity of individual turkeys, which has been reported to be below 30 birds (Buchholz, 1997; Healy, 1992). Birds are housed in open barns often without internal pen divisions, with no introduction of unfamiliar individuals and a stable group composition throughout the cycle, apart for the removal of hens in mixed-sex systems (EFSA, 2026). Given these constraints, measures preventing Group stress focus primarily on reducing the potential for conflict through environmental management rather than social manipulation. Environmental management encompasses the provision of enrichment strategies that reduce stress and aggression in large groups. These measures include the use of elevated structures and platforms, visual barriers to interrupt lines of sight and promote spacing, as well as foraging and exploratory materials that encourage natural behaviours and help disperse activity. Covered verandas and access to outdoor ranges, where permitted, can further support welfare by providing birds with more space and varied environments. These enrichment strategies are discussed in more detail in the dedicated enrichment section (see Section 3.2.2.7). Based on broiler/laying hen literature (Estevez et al., 2007), EFSA experts assume that maintaining stable group composition from placement and minimising disruptions such as flock thinning events can help stabilise social dynamics in turkeys. Additionally, management should aim to reduce competition and stress within large groups through appropriate resource distribution (e.g. feeders, drinkers) and providing enough space for birds to avoid close and sustained contact, even if individual recognition

is not possible (Buchwalder & Huber-Eicher, 2005; Kiani, 2022). Enriching the environment with visual barriers or pecking and foraging materials, and ensuring sufficient feed and water accessibility, may reduce Group stress.

3.2.7.4 | Mitigation measures

Corrective measures targeting the hazard of too large group size in conventional production are limited by the structural and operational scale of commercial facilities. While reducing group size is not practical, adjusting the environment to influence how birds interact within large groups remains the most applicable approach (Busayi et al., 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU); Kiani, 2022). This may include environmental modifications such as enriching the environment with elevated structures, visual barriers, pecking and foraging materials, adjusting lighting levels and ensuring sufficient access to feed and water to reduce Group stress.

3.2.8 | Nest conditions

3.2.8.1 | Background

EFSA was requested to assess the risks to the welfare of turkey breeders posed by inadequate nest conditions (ToR-B, Request 2c of the mandate). The types of nest boxes used in the commercial facilities of turkey breeders, as well as in the laying phase of turkey hens, are described by EFSA (2026). This chapter focuses on the assessment of the welfare consequences of inadequate nest conditions in turkey breeder hens during the laying period when turkey breeder hens are above 32 weeks of age and are housed in a barn with individual nest boxes.

The scientific evidence retrieved from the literature on this topic in turkeys is scarce. Only a few studies have been performed, and they mainly focussed on aspects of nest conditions that may affect reproduction and productivity rather than welfare. However, some evidence on the welfare implications of nest conditions is available for other poultry species; for example, Villanueva et al. (2017) report that the provision of adequate nests allows laying hens to perform pre-laying behaviour and oviposition with minimal competition, avoiding frustration, stress and possibly retained eggs.

3.2.8.2 | Hazards linked with nest conditions and associated welfare consequences

Inadequate nest conditions may lead to the welfare consequence inability to perform pre-laying and nesting (maternal) behaviour, which can be identified by the ABMs proportion of eggs outside the nest, interrupted nesting behaviour and attempts at nesting behaviour (see Section 3.1.7).

Expressing nesting (maternal) behaviour is influenced by the possibility for the turkey hen to lay eggs in an adequate nest. When this possibility is not given, it may cause frustration leading to other welfare consequences, such as Group stress and Soft tissue lesions and integument damage.

Nest conditions are inadequate when, in the breeding facility, there are no nests, too few nests or the provided nests have inadequate design, functioning (e.g. light intensity, entrance, height, nesting material) and/or size (dimensions).

A few studies, published several decades ago, reported on the preferences of wild and commercial turkeys for certain aspects of nest design. For instance, (Burleigh, 1958 as cited by; Millam, 1987), reported a tendency of *Meleagris gallopavo silvestris* (a subspecies of wild turkeys), to choose concealed areas instead of open spaces, whereas *Meleagris gallopavo merriami* frequently nest in open spaces (Ligon, 1946; Millam, 1987).

The experimental studies reported in Millam (1987) analysed the light intensity preferred by 28 commercial turkey hens (Nicholas large white turkey) in nest boxes that had a 40 W frosted incandescent lamp which was either uncovered or partially or totally painted to provide diverse nest light intensities at hen's head level. The hens were housed in experimental rooms with incandescent lamps providing 50–70 lux at bird level. Two levels of nest box interior illumination were tested in a group of 14 hens: one with light intensity of 650–1000 lux (high), and one with light intensity of 0.5 lux (low). Most turkey hens avoided the highly lit nest boxes (only 3 out of 14 hens laid eggs in the nest boxes with high light intensity). In another experiment with 28 turkey hens housed in individual pens at low or high light intensity with the same lux as in the previous experiment, the level of light intensity in the nest boxes did not affect the frequency of nest visits or time spent nesting, which showed a high variability over time. Nest box light intensity did not impact the incidence of floor eggs, regardless of whether the turkey hens using the nests and floor layers were pooled, or whether the analysis was restricted to turkey hens using the nest boxes in each light intensity treatment group. There was a tendency for more floor eggs in the high light intensity group ($15.3 \pm 3.3\%$, $n = 12$) compared to the low light intensity group ($9.0 \pm 2.7\%$, $n = 10$). The results of these two experiments indicate that hens prefer low illumination when selecting nests.

Aviagen management guidelines recommend that the nests (but not the pen area) are darkened at the start of the production period, while at the peak of production light intensity above the nests is recommended to be the same as in the rest of the house, which is about 100–140 lux (Aviagen Turkeys, 2023b). This likely reflects a practical aim to avoid complete darkness due to production reasons rather than a warning against high light levels. On the other hand, experimental findings show that very high intensities (> 650 lux) in the nest area can disrupt pre-laying and nesting behaviour. Although such light levels are unlikely on farms, high light intensity is a potential hazard to consider in nest design and management.

As a part of the nest design, the entrance of both manual and automatic nests is usually fitted with a trap mechanism that allows easy access. The presence of a hen in the nest may attract other hens to try to share the nest, promoting gregarious nesting behaviour, but the trap mechanism prevents the entrance of more than one hen at a time. Gregarious nesting in laying hens has been linked to several welfare concerns, including increased aggression, feather loss, scratches, wounds and risk of suffocation (Tahamtani et al., 2018). The EFSA experts consider that risks associated with gregarious nesting also apply to turkey hens. If the push-off mechanism does not push the hen off the nest and the hen stays longer in the nest, nesting duration is increased and it may favour the occurrence of broodiness (Jiang et al., 2010; Millam et al., 1980). Broodiness is a natural nesting behaviour (see Section 3.1.7), and the presence of other hens trying to enter the nest may stimulate the broody hen to show aggressive or defensive behaviours (Jiang et al., 2010). These issues highlight the critical role of the trap mechanism, which must function effectively to prevent more than one hen from entering the nest simultaneously. Well-operating trap and push-off mechanisms help maintain individual nesting and reduce competition and aggression.

Broodiness has mainly been researched from the point of view of egg production and not from the welfare dimension. Broodiness is a natural behaviour of sitting in a nest on a clutch of eggs to incubate them. If this behaviour is thwarted (ABM interrupted nesting behaviour), it causes frustration (see Section 3.1.7). The turkey hens expressing broodiness will typically start showing signs of broodiness 3–4 weeks after the start of lay, followed by a drop in egg production (Aviagen Turkeys, 2023a). Up to 20%–30% of breeder hens of modern turkey breeder strains show broodiness (Brière et al., 2010). Signs of broodiness consist of spending a long time in the nests (if permitted) and, when approached, the broody hen might display aggressive behaviours such as hissing, raised back/neck feathers and pecking; this suggests broodiness to be linked to the welfare consequence Group stress. Broody management guidelines (Aviagen Turkeys, 2023a) report that temperatures above 20°C–25°C are linked with broodiness.

Broody hens are usually identified by visual inspection, the net/curtain system and are spray marked and moved to broody pens (Aviagen Turkeys, 2023a). The average duration of stay in broody pens increased with the hens' age. Hens showing broodiness after 18–20 weeks of lay tended not to return to egg production in the laying cycle of 27 weeks. A net/curtain system, as described in Aviagen Turkeys (2023a), may be integrated into nest design to manage broodiness by restricting hens' access to the nest or altering its visual environment. During the day, the hens are free to visit and leave the nests. Approximately 1 h after the last egg collection, a net or curtain is lowered 2–3 meters in front of and parallel to the nest boxes to separate hens still on the nests from the rest of the pen. By morning, hens found in the space between the nests and the barrier can be returned to the main pen, while those still occupying nests are likely broody and are removed from the laying pens. While the net/curtain system helps reduce prolonged nest occupancy and allows to identify broody hens, it may negatively impact hen welfare by limiting natural nesting behaviours and opportunities. Moreover, the turkey hens confined between the barrier and the nest boxes overnight may have restricted access to feed and water and to any available resources during this period.

Management of broody hens typically involves relocating them to broody pens, which are usually situated in the coolest part of the house and exposed to higher light intensity than standard laying pens. Aviagen Turkeys (2023a) indicate that typically broodiness can be reversed after three to 4 days if the broody hens are identified at an early stage (Aviagen Turkeys, 2023a). Hens expressing broodiness a second time stayed longer in broody pens than those having experienced it once (Brière et al., 2010). This practice of moving broody hens to a broody pen benefits the welfare around nesting of the non-broody hens, but may result in the welfare consequences Group stress and Soft tissue lesions and integument damage for the broody hens, because it disrupts broody behaviour, limits the expression of pre-laying and nesting behaviour, and may increase group stress due to environmental changes and social disruption because of mixing new animals. High stress levels in such settings could potentially lead to increased pecking, aggression and the occurrence of wounds. Although no direct data are currently available to confirm these outcomes, the known associations between environmental stressors and aggressive behaviour in laying hens suggest that the welfare implications of this practice for turkeys warrant further investigation.

Inadequate nest dimensions or provision of an insufficient number of nests (high ratio of hens: nest boxes) negatively affect the welfare of turkey hens, leading to the welfare consequence Group stress and, consequently, Soft tissue lesions and integument damage. Berg et al. (2003) in an observational study reported that flocks reared at a high floor stocking density (2.4 hens/m²) and low hen-to-nest ratio (4.3 hens/nest) had a lower prevalence of severe pecking wounds on the back and rump part of the body compared to hens reared at a lower floor stocking density (2 hens/m²) and higher hen-to-nest ratio (5 hens/nest). The difference was statistically significant, but because hen stocking density and the hen-to-nest ratio were modified simultaneously in opposite directions, the biological interpretation is more difficult. Therefore, it is not possible to separate the relative contribution of each factor, and the results reflect the combined effect of these management conditions, rather than the specific impact of nest availability alone.

Cannibalistic pecking in turkey breeders was primarily directed at the back and rump, not the cloaca, although limited nest access and high hen-to-nest ratio stocking density may still increase the risk of such behaviours (Berg et al., 2003). Marks (2017) did not find cloacal cannibalism in turkey hens housed with a hen-to-nest ratio of 5:1. The Animal Welfare Approved certification (A greener world, online), requests that at least 1 nest box is available for every 4 turkey hens, with communal nests offering a minimum of 400 square inches (2580.64 cm²) per turkey and measuring 20 by 20 inches (50.8 cm by 50.8 cm). To obtain adequate access while minimising competition and stress, and prevent egg crushing in the nest, the US National Turkey Federation's Animal Care Guidelines (National Turkey Federation, online) recommends no more than 7 hens per nest, with 90% of nest gates accessible and open to let hens move in and out freely. The same Guidelines

emphasise that a higher number of nest boxes may promote broodiness by encouraging hens to remain in the nest longer than necessary to lay the egg, thus reducing egg productivity. In Finland, the practice is approximately one nest available for every four turkey hens (EFSA Public call for evidence 2024, PC 0741, 1, Länsi-Kalkkuna Ltd). Industry guidelines recommend 4.5 to 5 hens per nest for heavy hens and 5 to 5.5 hens per nest for medium hens (Aviagen Turkeys, 2020). However, there is limited scientific evidence to determine the minimum hen-to-nest ratio and no evidence to determine the minimum nest space preventing associated welfare consequences.

The lack of nesting material or the provision of inadequate nesting material are also linked to the occurrence of the welfare consequence inability to perform pre-laying and nesting (maternal) behaviour. Brood patch stimulation is required for the development of incubation behaviour and nesting physiology in turkey hens. A study conducted by Book and Millam (1992) tested the hypothesis that differences in the tactility of nest box substrates might alter the normal progression of the lay cycle. A total of 22 hens were offered nest boxes containing either pine shavings or artificial turf as a substrate. Changes in nest box usage (in terms of minutes in the nest/hen/day and number of visits to the nest/hen/day), serum prolactin levels (linked to broodiness) and egg production were monitored over a 23-week photo-induced laying cycle. No significant differences were detected in any indicator, and the authors concluded that the tactile stimulation provided by these materials is insufficiently different to produce significant differences with the population of hens used in the test. The lack of difference may also be attributed to the low number of turkey hens ($n=22$) used in the study. In a study performed with 4320 laying hens, Guinebretière et al. (2013) compared the effect of two types of nest flooring (plastic mesh and artificial turf) and found a lower mortality rate with artificial turf as compared to plastic mesh (2.2% and 3.3%, respectively). Nonetheless, the causal link of these findings could not be explained by the authors, who indicated that further experiments are required to clarify the obtained results. However, the available scientific evidence on the role of loose nesting material in the prevention of inability to perform nesting and pre-laying (maternal) behaviour in turkey hens is limited. Wild turkeys (*Meleagris Gallopavo Ocella*) hens scratch shallow depressions in the soil, and the hen places over the egg a few strands of debris before leaving (Williams Jr et al., 1971). Laying hens (*Gallus gallus domesticus*) do not bring material into the nest, but use loose material already in the area of the nest. Laying hens also tend to scratch and mould the material into a bowl-like depression, as part of their nesting behaviour. They prefer loose, moldable and soft materials that allow them scratching, shaping and settling. Preferred substrates include peat, sand and wood shavings.

3.2.8.3 | Preventive measures

Measures preventing turkey breeder hens from experiencing the welfare consequences associated with inadequate nest conditions include the provision of a sufficient number of nest boxes of adequate size and design, with correct functioning of the trap and push-off mechanisms, and the adoption of an adequate lighting programme and nesting material which meet the hens' needs and stimulates the expression of pre-laying behaviour.

At present, there is a lack of scientific research establishing what constitutes an appropriately designed nest from the turkey hen's perspective. According to the guidelines of Aviagen for breeding turkeys, the nest has an adequate size when hens have enough space to comfortably turn around and stand, and is adequately designed when hens can be gently moved off the nest (Aviagen Turkeys, 2023c).

3.2.8.4 | Corrective and mitigation measures

Corrective and mitigation measures mainly focus on adjusting the hen-to-nest ratio when aggressive behaviours around the nest are observed. In principle, the fewer hens per nest, the better for the hen welfare because there will be less competition for the nests available. However, some laying hens may prefer nests in specific locations compared to (Riber, 2010), suggesting that competition may still exist. Comparable behaviour may occur in turkey hens. The effects of inadequate nesting material can be corrected by providing additional nesting material of adequate quantity and quality.

Early intervention in case of a malfunctioning trap or push-off mechanism will mitigate Group stress.

3.2.9 | The practices of flock thinning and removal of hens

3.2.9.1 | Background

The mandate asked to assess the risks related to the practice of flock thinning in turkeys kept for meat production. This practice is similar (with likely overlapping welfare implications) but not identical to the practice of the removal of hens, which is related to the mixed keeping of males and females that EFSA was requested to assess under ToR-B, Request 2a of the mandate. Due to these similarities, the EFSA experts considered two scenarios (Section 1.2), namely (1) the practice of flock thinning and (2) the practice of the removal of hens, which are assessed together in this section. Flock thinning (also referred to by the industry as partial depopulation) is a practice applied in poultry production where a subset of birds is removed for slaughter at planned times to avoid exceeding the target stocking density (kg/m^2), while the remaining birds grow to the set target slaughter weight (Allen et al., 2008). Farms applying this practice initially place a high number of turkeys in the barn. If all initially placed turkeys were to reach slaughter weight at the same time, barn capacity would be exceeded. However, as flock thinning is applied, the space previously occupied by turkeys sent to slaughter is made

available to the turkeys that remain in the barn. In turkeys, the practice of flock thinning is applied by removing a subset of birds from all-tom or all-hen flocks (Figure 6A). The second scenario, the removal of hens, occurs when toms and hens are kept in the same farm but reared in separate areas of the same barn or different barns. Here, the number of toms placed in the designated tom area will exceed the capacity of that area if they are kept only in that area until reaching slaughter weight. As hens are sent to slaughter earlier than toms, the space previously occupied by the hens is made available to the toms, thereby increasing their designated space during the last part of the growing period (Figure 6B). In both scenarios, multiple thinning cycles may be needed to empty the barn, meaning that birds may experience the welfare consequences described further multiple times. More detailed explanations of the practices are provided elsewhere (EFSA, 2026).

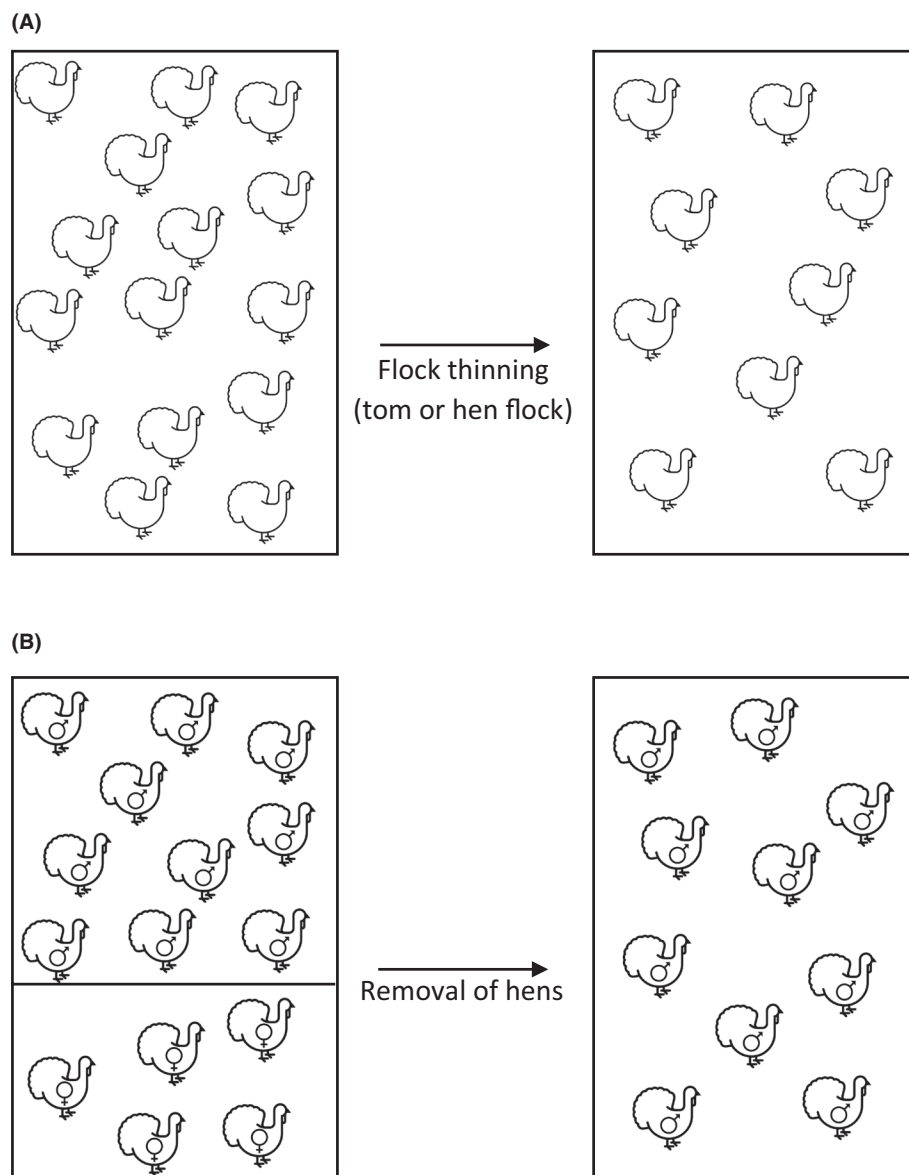


FIGURE 6 Visual presentation of (1) flock thinning and (2) removal of hens in turkey flocks. (A): In the scenario of flock thinning, a subset of turkeys is removed for slaughter from a shared space in either a tom or hen flock. (B) In the removal of hens scenario, toms (♂) and hens (♀) are kept in the same farm but in a separate area within the same barn or different barns. Once the hens are sent to slaughter, the space is made available to the toms.

Both practices (flock thinning and removal of hens) are closely connected to the preparatory steps associated with sending turkeys to slaughter, e.g. feed and water withdrawal, catching and handling of turkeys, social disruptions in flocks, access to an unfamiliar environment and conditions associated with transport (Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). The welfare of turkeys during transport (EFSA AHAW Panel, 2022a) and slaughter (EFSA AHAW Panel, 2019) is out of the scope of the current mandate. However, some of the preparatory steps may also influence the welfare of the turkeys that remain on farm, and this aspect is considered here.

3.2.9.2 | *Hazards linked with the practice of flock thinning and removal of hens, including associations with welfare consequences*

When the practice of flock thinning or removal of hens is applied, turkeys experience peaks in stocking density (i.e. before and after flock thinning or removal of hens). As such, all welfare consequences described in Section 3.2.3 for the hazard 'insufficient space allowance' ('too high stocking density') should be considered, namely Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour and Inability to perform exploratory/foraging behaviour (and more indirectly Locomotory disorders (including lameness), Soft tissue lesions and integument damage, heat stress, gastroenteric disorders and respiratory disorders). The extra space made available to the remaining birds after flock thinning or removal of hens means that there is a (temporary) reduction in stocking density (kg/m^2) for the remaining birds, however this then increases again as birds grow. The welfare consequences thus may apply to the flocks both before and after the practice of flock thinning and removal of hens. In the case of removal of hens, the welfare consequences are only experienced by toms. To avoid repetition, these welfare consequences (including the preventive and mitigation measures), are not discussed in-depth where they relate to 'insufficient space allowance' ('too high stocking density') only (Section 3.2.3). Instead, the following section focusses on the welfare consequences (for the remaining birds) in relation to aspects specifically associated with flock thinning or removal of hens. However, all welfare consequences were used in the assessment of the practices of flock thinning and removal of hens by the EFSA experts.

In broiler chicken flocks, there was a small protective effect of flock thinning on the risk of condemnations due to dermatitis in both the first and second delivery of thinned flocks (batch 2 odds ratio: 0.8, 95% CI: 0.75–0.87; batch 3 odds ratio: 0.8, 95% CI: 0.79–0.90) compared to flocks (batch 1) where all birds were delivered on the same date (Alfifi et al., 2020). The thinned flocks represented 21.3% of analysed data in this study, with an average difference of 3.3 days of slaughter age between batches. de Jong et al. (2012) also reported an interaction between depopulation method (flock thinning vs. complete depopulation) and age of the flock (<38 days, 38–41 days, >41 days) where broiler chickens thinned at <38 days had lower footpad dermatitis scores than same age or older depopulated flocks without thinning. The protective effect of flock thinning has been linked to the increased space for the remaining broiler chickens, reducing the risk of being overcrowded (e.g. risk of being climbed on by other birds) and the contact with wet litter (Alfifi et al., 2020). However, de Jong et al. (2012) also reported that farmers who do not apply flock thinning and send birds to slaughter at an early age generally applied elevated stocking density, which increased the risk of wet litter. It is thus difficult to determine whether the flock thinning itself was protective or the conditions of higher stocking densities and potentially higher litter moisture in completely depopulated flocks caused increased footpad dermatitis. While no studies were found to support a similar trend of less footpad dermatitis in turkeys in thinned flocks, the mechanism whereby the increased space after flock thinning, or removal of hens, reduces the risk of the welfare consequence Restriction of movement is the same and thus likely leads to similar benefits. However, the timeframe under which the increased space is beneficial is unclear. It may be temporary as the remaining turkeys are kept in the barn for a longer period than the broiler chickens (particularly with the practice of the removal of hens where toms remain in the barn for additional weeks) and continue to grow, meaning that stocking density increases again and peaks when the remaining birds are sent to slaughter.

While stocking density has been investigated in turkeys (see Section 3.2.3), the practices of flock thinning and removal of hens per se and their welfare implications have, to the best of our knowledge, not been studied in turkeys. Apart from effects mediated through stocking density, the practice of flock thinning impacts turkey welfare in terms of Handling stress (catching process), Sensory overstimulation (catching process), Prolonged hunger and Prolonged thirst (feed and water withdrawal), Group stress (changing group size) and Gastroenteric disorders (risk potentially heightened by breaches of biosecurity during catching process). Some of these consequences are likely less relevant in the scenario where hens are removed, e.g. the catchers do not need to enter the tom area (but toms may still experience stress from the happenings in the hen area), the group size of toms does not change and fasting/water restriction may only be limited to the hen area. It should also be noted that when flock thinning or removal of hens occurs in multiple batches, the processes are repeated and birds may experience the associated welfare consequences multiple times.

The practice of flock thinning is associated with Handling stress for the turkeys that need to be caught for transport to slaughter (Erasmus, 2018; Prescott et al., 2000; Scanes et al., 2020). This process is out of the scope of this SO (EFSA AHAW Panel, 2019). However, as catching teams need to approach, fence off areas and catch other turkeys, it is expected that this can also lead to stress in the turkeys that remain in the barn (Hernandez et al., 2025). Flighty or aggressive turkeys pose a risk of injuries to themselves and the catchers (Hernandez et al., 2025). Furthermore, the process of catching introduces cues that can lead to Sensory overstimulation as abrupt exposure to outdoor light, temperatures or air flow have been described to make turkeys more flighty (Hernandez et al., 2025). In the scenario where hens are removed, toms may experience some of these stressors to a lesser extent when the hen area is in the same barn and the fenced off area only needs to be opened up to them. However, when hens are in a separate barn and toms would need to be moved to the separate barn to make use of that space, then toms would experience more stressors.

Additionally, flock thinning and removal of hens requires personnel and equipment to enter the barn, which poses a risk for biosecurity of the remaining birds. Biosecurity is an important aspect in disease management, and the practice of flock thinning and removal of hens in which catching teams enter the barn may introduce or enhance the spread of pathogens through for example the catching equipment and personnel, leading to health-related welfare consequences such as Gastroenteric disorders or Respiratory disorders for the remaining turkeys. Research on the direct effects of flock thinning or removal of hens in turkeys is limited, and literature on broiler chickens focuses on pathogens from a public

health perspective which do not necessarily cause clinical disease in birds. For example, in broiler chickens, flock thinning is associated with increased risk of *Campylobacter* spp. colonisation (Higham et al., 2018; Koolman et al., 2014), though this is not always observed (Russa et al., 2005). However, the EFSA BIOHAZ Panel (2020) suggested that discontinuing flock thinning would also improve broiler welfare by eliminating the associated stress. Noradrenaline, a hormone involved in the acute stress response via the sympathetic-adreno-medullar axis, has been shown to increase the growth and virulence of certain *Campylobacter* species in ex-vivo studies and to increase colonisation in chickens (Aroori et al., 2014). In turkeys, it has been suggested that the removal of hens may also increase the risk of *Campylobacter* spp. colonisation in the remaining toms (Blomvall et al., 2023), and this may also be extrapolated to the practice of flock thinning of turkeys from the same shared area. Perko-Mäkelä et al. (2009) reported that three tom flocks which were negative for *Campylobacter* spp. before slaughter of hens remained negative 2 to 3 weeks later, while one tom flock became positive after the slaughter of hens. They highlighted the importance of biosecurity measures (e.g. catching equipment, personnel) when catching and loading the hens before slaughter to minimise the risk of introducing *Campylobacter* spp. (Perko-Mäkelä et al., 2009). Other pathogens with higher relevance for turkey welfare may also be influenced by biosecurity implementation. For example, Lüning et al. (2023) found a lower risk of *Histomonas meleagridis* infection when equipment was cleaned and disinfected, though again this was not investigated in direct relation to flock thinning or removal of hens. Additionally, while litter is removed and replaced between flocks in Europe, it is not the case after flock thinning or removal of hens. With removal of hens, this may expose toms to other (unfamiliar) pathogens in the litter (Section 3.2.1).

Biosecurity measures were recently shown to correlate with welfare outcomes in commercial flocks in Hungary (Kovács et al., 2025). In this study, the AWIN protocol for turkey welfare (AWIN, 2015) was used to assess the welfare of tom flocks of 24 farms nearing slaughter (average 132 days, range 98–145 days, between 2833 to 26,819 birds present at time of visit) and the Biocheck.UGent questionnaire¹⁶ for biosecurity was completed. The questionnaire addressed external biosecurity (i.e. measures to prevent pathogens from entering or leaving the farm) and internal biosecurity (i.e. measures implemented to prevent the spread of pathogens within a farm). While the Biocheck.UGent questionnaire does not directly ask whether flock thinning or removal of hens is practised, the number of steps it takes to depopulate a turkey house is included in a subsection on depopulation under external biosecurity. The authors found a negative correlation between the external biosecurity score (average 51.9, range: 36–74; higher score is better) and the average welfare index (average 6.9, range: 2.1–14.2; lower score is better), implying that enhanced external biosecurity was associated with better welfare outcomes (Kovács et al., 2025). However, no correlation was observed between the average welfare index and the subscore for the category depopulation. The authors reported that organisation of farm management, hygiene measures between compartments, cleaning and disinfection measures on farm, and measures regarding visitors and farm workers were most influential regarding the average animal welfare index. Aspects in these categories may also play a role in flock thinning and removal of hens when catching teams enter the barns or compartments. Unfortunately, the authors only provided their results based on the aggregated animal welfare index and therefore it is not possible to tease apart which specific aspects of turkey welfare may be associated with certain biosecurity measures. Lastly, the authors also emphasised that correlation does not imply causation (Kovács et al., 2025). Further research would be needed to investigate the relationship between biosecurity and welfare of turkeys on commercial farms.

At the same time, flock thinning also implies that feed and water are withdrawn (Section 3.2.13) in the (entire) barn (Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). Feed can be withdrawn from turkeys about 2 h prior to catching (Bilgili, 2002) but commonly this happens between 4 and 8 h before catching (EFSA AHAW Panel, 2022a), though this may differ between countries, regions and even farms. Water is typically withdrawn from poultry when catching starts (reviewed by Wurtz et al., 2024). The EFSA recommended that for domestic birds feed withdrawal on farm should be avoided from a welfare point of view, and that to prevent Prolonged hunger total feed withdrawal should not exceed 6 h (EFSA AHAW Panel, 2022a). In the case of flock thinning, feed and water withdrawal would affect all turkeys in the barn, including those that would not be sent to slaughter. In the case of removal of hens, it depends on whether the feeder and drinker lines can be operated separately in the hen area and the tom area, and it would not be a hazard for the toms if the hens are in a separate barn. After flock thinning or removal of hens, the feeder and drinker lines are lowered, and the remaining birds have access to feed and water again. However, Corrier et al. (1999) found that within 2 h of feed withdrawal, broiler chickens in commercial flocks already showed a two-fold increase in pecking at the litter, which also contributed to increased incidence of *Salmonella* in the crop after feed withdrawal before birds were crated and transported to the slaughterhouse. In contrast, Rostagno et al. (2006) found no increase in *Salmonella* in turkeys sampled before feed withdrawal on farm and on the slaughterline. While turkeys sampled on the slaughterline also underwent catching, loading, transport and lairage, the authors suggested that the more established intestinal microbial community and more mature immune system in turkeys compared to broiler chickens could prevent new *Salmonella* infections (Rostagno et al., 2006). No other ABMs were measured in this study to evaluate whether feed withdrawal also led to changes in pecking behaviour in turkeys. The probability of turkeys to start feeding increases with time since last feeding (Howie et al., 2010). Thus, the returning access of the feeder/drinker lines may invite feeding/drinking and potential competition in the remaining birds (Group stress). To the best of our knowledge, however, no studies have investigated the effects of feed or water withdrawal during flock thinning or removal of hens on the behaviour or welfare of turkeys.

¹⁶<https://biocheckgent.com/en/questionnaires/turkeys>.

Lastly, the practice of flock thinning also changes group size (Section 3.2.7), and such social disruptions may lead to Group stress. However, since turkeys are only removed (no new turkeys are introduced), and space per bird is increased, the negative effect of flock thinning on Group stress may be limited. In experimental studies, aggressive behaviours in turkeys were more pronounced in small ($n=6$) than in large ($n=30$) groups upon introduction of unfamiliar turkeys (Buchwalder & Huber-Eicher, 2005). While with flock thinning or removal of hens, birds may cross paths with until then unfamiliar birds, it is unlikely that in commercial settings these practices lead to such small group sizes that birds may recognise one another and attempt to form a hierarchy. On the other hand, the larger space available may allow turkeys to show elements of aggressive behaviour that require more space (e.g. fights or leaps) but also provides more opportunities for avoidance (Buchwalder & Huber-Eicher, 2004). Disentangling the effects of space allowance and group size is difficult (Sections 3.2.7 and 3.2.3). In the case of removal of hens, if hens and toms were kept in the same barn, no changes occur in the group size for toms, unless a subset of the toms is moved to a separate barn.

As a summary, the welfare consequences associated with the practices of flock thinning and the removal of hens are shown in Table 11. For the removal of hens, a distinction was made between when the hen and tom areas are within the same barn or in separate barns as depending on these circumstances certain welfare consequence may not occur. Note that this table excludes the welfare consequences associated with insufficient space allowance (discussed in Section 3.2.3) which turkeys would be at risk of experiencing in all scenarios due to the peaks in stocking density before and after flock thinning and removal of hens. In the case of removal of hens, these welfare consequences are more likely in toms than hens because the toms are placed in the barn at a higher number as they later receive access to the hen area. However, it was not possible to quantify the intensity/severity of the welfare consequences that turkeys experience under the different scenarios and thus the EFSA experts only indicate when the risk of the birds experiencing the welfare consequence is present or not under certain conditions. Potential preventive and mitigation measures are also given. The preventive and mitigation measures are discussed separately for each practice, but as the welfare consequences are largely the same, reference is made to those measures mentioned in relation to flock thinning when applicable and only specifics or exceptions are noted for the removal of hens to avoid repetition.

TABLE 11 Overview of welfare consequences that turkeys remaining on the farm are at risk to experience when the practices of flock thinning or removal of hens are applied, including potential preventive or mitigation measures.

Welfare consequence	Flock thinning	Removal of hens (separate hen and tom area within same barn)	Removal of hens (hen and toms in different barn)
Handling stress	Yes; handling of birds during catching process in same area	No; no catching within tom area needed and hen area in same barn only needs to be opened up	Yes; toms need to be moved between barns
	Preventive measures: • Not possible Mitigation measures: • Training of staff	Preventive/mitigation measures: <i>Not applicable</i>	Preventive measures: • Not possible Mitigation measures: • Training of staff
Under-/overstimulation	Yes; due to handling of the birds and changing environmental conditions during catching process	Yes; due to handling of the hens and changing environmental conditions during catching process	Yes; toms need to be moved between barns
	Preventive measures: • Not possible Mitigation measures: • Training of staff • Optimise farm conditions (light, temperature, air flow)	Preventive measures: • Not possible Mitigation measures: • Training of staff • Optimise farm conditions (light, temperature, air flow)	Preventive measures: • Not possible Mitigation measures: • Training of staff • Optimise farm conditions (light, temperature, air flow)
Prolonged hunger	Yes; feeder lines are raised during catching process in same area	Yes; feeder lines in tom area are raised during catching of hens in same barn	No; feeder lines in tom area do not need to be raised during catching of hens
	Preventive measures: • Not possible Mitigation measures: • Limit total duration of feed withdrawal	Preventive measures: • Design feeder lines such that they can be operated independently in hen and tom areas Mitigation measures: • Limit total duration of feed withdrawal	Preventive/mitigation measures: <i>Not applicable</i>
Prolonged thirst	Yes; water lines are raised during catching process in same area	Yes; water lines in tom area are raised during catching of hens in same barn	No; water lines in tom area do not need to be raised during catching of hens
	Preventive measures: • Not possible Mitigation measures: • Limit total duration of water withdrawal	Preventive measures: • Design water lines such that they can be operated independently in hen and tom areas Mitigation measures: • Limit total duration of water withdrawal	Preventive/mitigation measures: <i>Not applicable</i>
Group stress	Yes; social disruption due to removal of birds from same area; potential competition around resources (e.g. feeders/drinkers) once birds regain access	Yes; no changes in group composition but potential competition around resources (e.g. feeders/drinkers) once birds regain access	Yes; social disruption due to splitting of group of toms across different areas
	Preventive measures: • Not possible Mitigation measures: • Provide access to resources or enrichment	Preventive measures: • Design feeder/water lines such that they can be operated independently in hen and tom area Mitigation measures: • Limit total duration of feed/water withdrawal	Preventive measures: • Not possible Mitigation measures: • Provide access to resources or enrichment

TABLE 11 (Continued)

Welfare consequence	Flock thinning	Removal of hens (separate hen and tom area within same barn)	Removal of hens (hen and toms in different barn)
Gastroenteric disorders	Yes; increased risk due to personnel/equipment entering the same barn	Yes; increased risk due to personnel/equipment entering the hen area that toms are given access to; toms are kept on litter that was in the hen area	Yes; increased risk due to personnel/equipment entering the hen area that toms are given access to; personnel/equipment enter tom area to move toms; toms are kept on litter that was in the hen area
	Preventive measures: • Not possible Mitigation measures: • Biosecurity measures for equipment and personnel	Preventive measures: • Not possible Mitigation measures: • Biosecurity measures for equipment and personnel • Remove and renew or top-up old litter	Preventive measures: • Not possible Mitigation measures: • Biosecurity measures for equipment and personnel • Remove and renew or top-up old litter

3.2.9.3 | Preventive measures

The prevention of the welfare consequences that birds may experience when subjected to the practices of flock thinning and removal of hens consists in avoiding these practices.

Flock thinning: to discontinue the practice of flock thinning, the preventative measure would be to place a sufficiently low number of poults in a barn that allows all birds of the same sex in the same barn to be sent to slaughter at the same time. The number of poults to place needs to meet the minimum space allowance (m^2/bird) recommendation for the target weight at the slaughter age (Section 3.2.3).

Removal of hens: the same as for flock thinning, particularly for the toms that are placed in higher numbers in the tom area initially.

The welfare consequence of Handling stress is not applicable for toms when they are housed in a separate area from hens in the same barn. The hen area only needs to be opened up to the toms. From a handling perspective, it is therefore suggested to plan the removal of hens in such a way that hens and toms are in the same barn.

The welfare consequences of Prolonged hunger and Prolonged thirst are not applicable for toms when they are housed in a separate barn, and can also be prevented when they are housed in a separate area in the same barn when the feeder and drinker lines can be operated independently in each area.

3.2.9.4 | Measures mitigating the welfare consequences

The mitigation measures to limit the effects of flock thinning and removal of hens on the welfare of turkeys are mainly aimed at limiting Handling stress and Sensory overstimulation, ensuring good biosecurity practices, and limiting the duration of feed/water withdrawal and minimising Group stress in the remaining birds.

Flock thinning:

Proper animal handling may be promoted through formal training tools and informal training methods such as observing or learning from experienced turkey handlers, as suggested by Hernandez et al. (2025). Some studies have investigated the fear responses of turkeys to humans through voluntary approach tests or stroll tests, where an unfamiliar human walks at a constant speed through the flock. The results from these studies suggest that increased contact with humans reduces fearfulness in turkeys (Botheras et al., 2008; Erasmus & Swanson, 2014). Thus, the human-animal relationship between turkeys and caretakers on farm throughout the rearing period should also be considered as this may influence the response of the birds to personnel at time of flock thinning or removal of hens.

Optimising farm conditions to ensure e.g. consistent light (interior/exterior), temperature and air flow, is believed to help with herding turkeys by keeping appropriate levels of bird activity and movement, while minimising Handling stress and Sensory overstimulation (Hernandez et al., 2025).

Good biosecurity practices should be followed by all persons participating in the flock thinning and should consider both personnel and any equipment brought in (Alfifi et al., 2020).

To minimise the effects of feed/water withdrawal on the turkeys that remain on the farm, the feed/water lines should be made available once the turkeys that are sent to slaughter are removed (Section 3.2.13).

In general, providing resources (e.g. feeders, drinkers, visual barriers, elevated structures, foraging and pecking material) will aid in mitigating Group stress (Sections 3.2.2 and 3.2.7).

Removal of hens:

The mitigation measures to reduce Handling stress are the same as for flock thinning.

The mitigation measures to reduce Sensory overstimulation are the same as for flock thinning.

The mitigation measures to reduce Prolonged hunger and Prolonged thirst are the same as for flock thinning. They only apply to the case where hens and toms are in separate areas within the same barn and feeder and drinker lines cannot be operated independently in each area.

The mitigation measures to reduce Group stress are the same as for flock thinning. In the case where toms are kept in a separate area within the same barn there is no change in group composition (no social disruption). However, there may be secondary Group stress if feeder and drinker lines cannot be operated independently in each area due to the feed or water withdrawal, and potentially increased competition once access is regained.

The mitigation measures to reduce Gastroenteric disorders are the same as for flock thinning. However, in the case of removal of hens, the toms are exposed to other litter, as this is unlikely to be removed, which may pose an extra source of (unfamiliar) pathogens.

3.2.10 | The practice of mutilations

3.2.10.1 | Background

Mutilation is the removal or damage to an innervated part or parts of the body, due to either an operation or a trauma (van Niekerk & de Jong, 2007). This excludes the horny dead body tissue and feathers. It can be performed on different body parts of the turkey. In turkeys, some mutilations are common for both sexes (e.g. beak trimming and toe trimming), while others are only performed on males (e.g. desnooding). The mandate requested to assess the risk to welfare posed by three different types of mutilations, namely beak trimming, toe trimming and desnooding. Spur removal was more commonly carried out in the past (RSPCA, 2020), but appears currently to occur at very low prevalence in the EU, if at all, and will not be dealt with further in this section. Whether the mutilations are performed and on which animal category (breeders/others) varies between EU member states and regions (for a review see EFSA, 2024).

3.2.10.2 | Description of the mutilations

3.2.10.2.1 | Beak trimming

Beak trimming is performed to reduce the prevalence and severity of damage caused by injurious pecking, which includes feather pecking, cannibalistic pecking and aggressive pecking. The procedure involves the removal of up to one-third of the upper beak, measured from the nostrils to the tip, of the day-old turkey poult at the hatchery. It is the most commonly performed mutilation in turkeys, and it is practised on both toms and hens regardless of whether they are destined for meat production or breeding. Turkey breeders may be exposed to a second beak trimming later in life to remove potential regrowth, typically around 16 weeks of age (European Commission, 2024a). Different methods can be applied, including arc-trimming (also termed electrical, electronic or Bio-beaker trimming), hot-blade trimming and infra-red trimming (Table 12). Regrowth occurs regardless of the method used, but the rate of regrowth is higher for hot-blade trimming than for infra-red trimming (Gentle et al., 1995; Marchant-Forde & Cheng, 2010). This may be explained by the latter affecting the corneum-generating basal tissue and inducing less post-trimming inflammation, both factors that inhibit further germ layer growth (Marchant-Forde & Cheng, 2010). Comparison with other trimming methods was not found. Reportedly, cold blade (scissors/secateurs) beak trimming has been applied in the past but is no longer being used for day-old turkeys in the EU Member States (EFSA, 2024). It may be used during a second trim of older birds. Infra-red beak trimming appears currently to be the most commonly used method (EFSA, 2024), which is also the beak-trimming method reported to have the least negative impact on poultry welfare (for a comparison of beak-trimming methods, see EFSA AHAW Panel (2023b). Respondents from 10 out of the 17 EU Member States that answered a questionnaire on the occurrence of beak trimming reported that this practice is carried out in their countries (EFSA, 2024).

TABLE 12 Different beak trimming methods in turkeys.

Method	Description	References
Arc/electrical trimming	An electric arc is used to cauterise and remove the beak tip. Typically applied at hatch. Minimises bleeding from the wound.	Cunningham et al. (1992), Leighton Jr. et al. (1985), Noble et al. (1996), Noll et al. (2006)
Hot-blade trimming	A heated blade trims either both upper and lower beak parts simultaneously (block trimming) or only the upper beak (top-beak-only trimming). The heat cauterises and minimises bleeding from the wound. Typically applied within the first 10–14 days of age, but due to regrowth, it may be reapplied at older ages.	Noble et al. (1996), Noll et al. (2006)
Infrared trimming	Infrared energy is directed to the beak tip, causing tissue necrosis to occur over several days. Applied at hatch. No open wound is created. Currently used in the EU for newly-hatched poults	Busatta et al. (2024), Noll et al. (2006), Struthers, Fiss, et al. (2022)
Secateurs	A sharp pair of cold secateurs is used to remove the beak tip. Bleeding from the wound occurs. Typically applied when beak trimming is repeated in older birds (e.g. turkey breeder hens).	Gentle et al. (1995)

3.2.10.2.2 | Desnooding

Desnooding is the removal of the snood, which is the fleshy vascular appendage on the head of the turkeys. The snood becomes large in particular in tom turkeys as they mature. In addition to a sexual function, it is also involved in thermoregulation through heat dissipation (Buchholz, 1996; Munson, 2025). Desnooding is done by manual pinching-out using just the fingers/nails of the operator or by using nail clippers, tweezers or surgical scissors, and it is usually carried

out at the hatchery or upon arrival at the farm (European Commission, 2024a, 2024b). Desnooding has been reported to be practised to some extent in three EU Member State in turkey breeder toms and in one EU Member State in toms kept for meat production. In France, approximately 25% parent flocks of breeder toms of specific genetic lines are desnooded (European Commission, 2024a). In Italy, one of the two main turkey integrators practices desnooding of the toms of parent flocks after arrival on farm (European Commission, 2024b).

3.2.10.2.3 | Toe trimming

Toe trimming is the burning of the germinal bed in a toe, which removes the claw and prevents its regrowth (Mailyan & van Schie, 2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung). This is typically done at the joint between the first and second phalanges or at the base of the nail (Connor & Cowan, 2020). When performed in turkeys, the procedure typically involves the three forward-facing digits. It is done at the hatchery on both male and female day-old poults, typically using a trimming method based on microwave heat (Gorans, 1993). Microwave trimming consists of an automated system in which the part of the toes to be trimmed is exposed to microwaves penetrating the tissue of the toe, heating and necrotising it. The treated tissue falls off 1–3 weeks post-treatment (Gorans, 1993). Historically, toe trimming was performed using methods like hot blades, nail clippers, scissors or surgical shears (Fournier et al., 2014).

It has been reported that the majority of the EU Member States do not toe-trim turkeys. Among those that do, the prevalence of toe trimming is very variable (EFSA, 2024). In Italy, where the reported stocking density of turkey hens kept for meat production is 60 kg/m², about 60%–70% of the hen flocks are toe trimmed. There is no information on toe trimming in Italian tom flocks. In France, around 40% of the flocks are toe trimmed (European Commission, 2024a), and the industry maintains stocking densities between 45 and 60 kg/m² (European Commission, 2024a). The upper end of this range are rather high stocking densities compared to those typically applied in Member States, where toe trimming is omitted (e.g. Finland and Germany, where stocking density in hen flocks is maximum 46 and 52 kg/m², respectively).

According to Fournier et al. (2015), a histological examination of the toes of turkey toms trimmed using microwave heat indicated that by day 8, trimmed toes had complete epithelial recovery over the underlying healing tissue, and full healing was achieved by day 14. In addition, the toes were on average 91.9% shorter than the toes of non-trimmed birds. Toe length has been shown to be more variable in toe-trimmed toms and hens compared to toe-intact turkeys (Fournier et al., 2012; Fournier et al., 2015). Digit II (i.e. the inside anterior toe) has been reported to be trimmed more severely (i.e. shorter), but more uniformly (regarding length) than the other two digits (Fournier et al., 2015).

3.2.10.3 | Welfare consequences associated with mutilations

Since mutilations are performed on living and thus innervated tissue, the procedures will very likely lead to acute pain, and chronic pain may also occur. Most research on the welfare consequences of mutilations in turkeys is performed on beak trimming, whereas the other types of mutilations have received little attention. The welfare consequences induced may vary between the different types of mutilations due to the function of the body part mutilated, potential differences in the degree of innervation of the tissue mutilated and the method used to perform the mutilation.

3.2.10.3.1 | Beak trimming

Most research on the welfare consequences of beak trimming has focused on laying hens. However, the beak of turkeys is anatomically similar to that of laying hens (*Gallus gallus domesticus*) (Gentle et al., 1995), meaning that knowledge from the research on laying hens can be extrapolated to turkeys.

The dermis at the tip of the upper beak contains large numbers of nerve fibres and sensory receptors including thermoreceptors (sensation of temperature), nociceptors (sensation of pain) and mechanoreceptors (sensation of pressure and texture) (Fiedler & König, 2006; Gentle, 1989), which are lost or damaged in beak-trimmed birds (Gentle et al., 1995). Furthermore, behavioural studies have shown a loss of magnetoreception following beak trimming, which causes a deterioration of spatial orientation (Freire et al., 2011). Although the target of beak trimming is the upper beak, gross pathological and histological examination of the beaks of turkey poults exposed to infra-red beak trimming has shown that not only the upper beak, but also the lower beak tip is damaged by beak trimming (Fiedler & König, 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 5 - Deutscher Tierschutzbund e.V.).

Gentle et al. (1995) applied one of three methods of beak trimming to turkey poults: electrical (day-old), hot-blade (6 or 21 days of age) and secateurs (6 or 21 days of age). At 24 h, 21 days and 42 days after trimming, poults were killed and their beaks were histologically examined. In all beak trimming treatments, regardless of method, age at trimming and time since trimming, the regenerating nerve bundles did not develop neuromas. In laying hens, it has been demonstrated that when beak trimming is carried out at older ages, however, neuromas may form. For example, when five-weeks-old layer-type males and females (*Gallus gallus domesticus*) were beak trimmed using hot blades, the regenerating nerve fibres had formed neuromas by 15 days after trimming (Breward & Gentle, 1985). Neuromas were well developed by 20–30 days and continued to develop until at least 70 days after trimming (Breward & Gentle, 1985; Gentle, 1986). In addition, abnormal spontaneous neural activity was reported to result from the neuromas (Breward & Gentle, 1985). Both the formation of neuromas and abnormal neural activity are indicative of chronic pain.

Beak trimming causes the welfare consequence Soft tissue lesions and integument damage due to the lesion inflicted on the beak. The procedure is generally considered to induce the negative affective state of pain, together with loss of function (Kuenzel, 2007). For example, Struthers, Fiss, et al. (2022) found increased resting behaviour in turkey poults at 1 day following infrared beak trimming, and Cunningham et al. (1992) showed that arc beak trimming was associated with an increase in inactivity in both sexes during the first 6 weeks of life. Cunningham et al. (1992) interpreted this result as an indication of pain inflicted by the procedure. However, Struthers, Fiss, et al. (2022) challenged this assessment as they found more than a doubling of the pecking force in 1-week-old infrared beak-trimmed turkey poults compared to beak-intact poults (14 N vs. 6 N), and used this finding to argue that no pain was inflicted by the beak trimming procedure. However, the authors had no explanation for why the beak-trimmed poults were more forceful during their pecking behaviour. The loss of receptors in the beak, as mentioned above, resulting in a lack of normal sensory feedback, may be a potential explanation. Furthermore, Struthers, Fiss, et al. (2022) found increased resting behaviour in turkey poults at 1 day of age and decreased exploratory behaviour at 6 days of age following infrared beak trimming compared to beak-intact poults.

Reduced or compromised expression of beak-related behaviours such as exploration, foraging and preening has been reported in beak-trimmed laying hens (*Gallus gallus domesticus*) and turkeys, meaning that beak trimming is also related to the welfare consequences Inability to perform exploratory or foraging behaviour and Inability to perform comfort behaviour. For instance, beak-trimmed laying hens have been observed to have higher infestations of ectoparasites than beak-intact hens, which is believed to be due to a reduced ability to preen (Chen et al., 2011; Mullens et al., 2010; Vezzoli et al., 2015) and leads to the related welfare consequence Skin disorders (other than soft tissue lesions and integument damage). Indeed, beak-trimmed (hot blade) laying hens were found to spend more time preening compared to their beak-intact counterparts, which was proposed by the authors to indicate a reduction in the effectiveness of preening stemming from altered beak shape, presence of pain or both (Marchant-Forde et al., 2008).

Likewise, pecking performed in connection with expression of exploratory and foraging behaviour has been shown to be reduced in turkeys beak-trimmed as day-old compared to beak-intact turkeys, both shortly after beak trimming (6 days old female turkey poults, (Struthers, Fiss, et al., 2022) and long after beak trimming (6–16 weeks old turkey hens, (Volkman et al., 2024). Layer pullets showed reduced exploratory pecking compared to beak-intact pullets during the six-week observation period following beak trimming using a hot blade trimmer at 16 weeks of age (Gentle et al., 1990). However, other studies on turkeys or laying hens (*Gallus gallus domesticus*) have found no difference between beak-trimmed and beak-intact birds (broiler breeder chicks 0–6 weeks old, (Gentle & McKeegan, 2007); laying hens from 5 to 30 weeks old, (Struthers et al., 2019)). Reduced expression of exploratory and foraging behaviour is thought to indicate acute and chronic pain and/or lack of basic requirements necessary for the fulfilment of behavioural needs (Duncan, 1998).

Noble et al. (1996) observed the number of turkey poults manipulating feed with their beaks at 0, 1, 2 and 3 weeks of age and found that arc beak trimming applied at hatch resulted in poults spending 4 times longer than beak-intact poults manipulating feed with their beaks at 2 weeks of age. This may have been a consequence of an inability to grasp the feed crumbles, as this is the age at which most beak tips fall off as a result of trimming. Inability to manipulate or ingest feed may lead to the welfare consequence Prolonged hunger. No difference was found at 0, 1 and 3 weeks of age in manipulating feed with their beaks, and body weight was not recorded in this study to assess the impact on feed intake. In contrast, Cunningham et al. (1992) found that beak-intact turkey hens fed more frequently than arc-beak-trimmed turkey hens during the first 2 weeks following hatch, whereafter the difference disappeared. In this study, no definition of feeding was provided, so it remains unclear whether the observers were able to distinguish feed ingestion from feed manipulation, but the body weight at 3 weeks of age was similar for beak-intact and beak-trimmed hens. In layer chicks, infrared and hot-blade trimming compared to no trimming resulted in a reduction of time spent feeding (infrared: at 1, 4, 5, 7 and 9 weeks of age; hot blade: at 1–2 weeks of age), number of feeding bouts (at 2–7 weeks of age) and mean bout duration (results on weekly pairwise comparisons not provided) (Marchant-Forde et al., 2008). Across all ages, there was an overall difference in feeding and resting behaviour between infrared-trimmed and control chicks, whereas hot-blade trimmed chicks did not differ from either. Infra-red trimmed chicks spent shorter time feeding (infrared vs. control: 46.01 ± 5.77 s vs. 74.59 ± 6.89 s), had fewer feeding bouts (1.67 ± 0.22 vs. 2.39 ± 0.23) and had shorter feeding bouts (18.58 ± 3.08 s vs. 26.40 ± 2.92 s). An opposite pattern was found for resting, with infra-red trimmed chicks spending more time resting (infrared vs. control: 27.82 ± 5.05 s vs. 11.39 ± 2.51 s), having more resting bouts (0.807 ± 0.14 s vs. 0.46 ± 0.14 s) and longer resting bouts (11.53 ± 2.33 s vs. 5.17 ± 1.11 s) compared to beak-intact chicks during the observation period (0–9 weeks of age).

Similarly, some studies found reduced drinking behaviour in turkey poults and layer chicks in the period following beak trimming, which may result in the welfare consequence Prolonged thirst. Arc-trimmed turkey poults were observed drinking less frequently than beak-intact poults at 2 weeks of age (Cunningham et al., 1992). This was also the case at 1 week of age, but only for the females, whereas no differences in drinking behaviour were observed in either sex from the third week of age. Likewise, Marchant-Forde et al. (2008) found that layer chicks beak-trimmed using infrared, but not those trimmed using hot blades, spent less time drinking (infrared vs. control: 3.36 ± 1.09 s vs. 10.18 ± 1.97 s), performed fewer pecks at drinker nipples (1.76 ± 0.60 vs. 5.79 ± 0.99) and had fewer (0.20 ± 0.07 vs. 0.55 ± 0.09) and shorter (1.72 ± 0.55 s vs. 5.68 ± 0.97 s) drinking bouts during the observation period (0–9 weeks of age) compared to beak-intact chicks. In addition, beak-trimming using a hot-blade trimmer on 16-weeks-old pullets resulted in reduced drinking behaviour compared to beak-intact pullets during the six-week observation period following the beak-trimming procedure (Gentle et al., 1990). Although none of the studies measured water consumption, a reduction in the performance of drinking behaviour could have led to decreased water intake, which may in turn negatively affect feed intake.

Body weight or body weight gain can be used to assess the welfare consequence Prolonged hunger. Some studies report a reduced weight gain in trimmed birds (16-week-old turkey hens, arc trimming, (Leighton Jr. et al., 1985); 2–4 weeks old layer chicks, hot-blade trimming, (Marchant-Forde et al., 2008); 2–7 weeks old broiler breeder chicks, infrared trimming, (Gentle & McKeegan, 2007)). However, others have shown no difference (turkey toms from 8 weeks of age, arc trimming, (Denbow et al., 1984) or higher body weight (turkey toms from 8 weeks of age, arc trimming, (Noble et al., 1994). At older ages, compensatory feeding may have occurred if beak trimming initially reduced feed intake. Cunningham et al. (1992) found that arc trimming affected body weight of the sexes differently, with beak-trimmed toms being heavier than beak-intact toms from 6 weeks of age, whereas beak-intact hens were heavier than beak-trimmed hens from 12 weeks of age. Noll et al. (2006) compared arc trimming, hot blade trimming, infrared trimming and no trimming of turkey toms and found no effects on body weight (measured at 3-week intervals until 18 weeks of age), but a higher mortality until 6 weeks of age was noted for hot-blade trimmed toms as compared to beak-intact toms.

3.2.10.3.2 | Desnooding

Desnooding causes the welfare consequence Soft tissue lesions and integument damage. One research study examined the effects of desnooding toms ($n=100$) using cold surgical scissors compared to keeping toms snood-intact ($n=100$), though assessing only the effects on body weight at 10 weeks of age and mortality (unknown at which age) (Holroyd & Perry, 1971). Results showed a mortality of 8% in snood-intact turkeys (3.13 kg of liveweight) vs. 6% in desnooded turkeys (3.10 kg of liveweight). The authors argued that desnooding had no effect on mortality and liveweight. However, no explanation or statistical analysis was provided.

An observational field study, involving 312 flocks of poults hatched in two hatcheries in the USA, examined the hatchery- and transportation-associated hazards for poult mortality in the first 14 days of life (Carver et al., 2002). Unlike in the EU, some flocks of female poults were desnooded. Of the 131 hen flocks included in the study, a few (not further specified) were desnooded and no effect of desnooding was observed on flock mortality. However, desnooding of toms reduced the risk of mortality within flocks compared to snood-intact flocks (Odds Ratio [95% confidence interval] of desnooded flocks at age 7 and 14 days, respectively: 0.29 [0.27–0.30] and 0.30 [0.29–0.32]).

Desnooding can be performed in the hatchery or on farm, and requires handling, which may result in the welfare consequence Handling stress. The welfare consequence Heat stress may also result from desnooding due to the removal of a body part involved in thermoregulation (Munson, 2025). In laying hens (*Gallus gallus domesticus*), it is known that trimming of the wattle and comb results in increased performance of thermoregulatory behaviour (i.e. panting and wing spreading) compared to untrimmed hens during exposure to high temperatures (26°C–35°C) over 52 h (AL-Ramamneh et al., 2016). There is no scientific information on whether the sexual behaviour expressed by desnooded turkey breeder toms differs from that of snood-intact toms, and whether desnooding leads to inability to express sexual behaviour.

3.2.10.3.3 | Toe trimming

Little is known on the welfare consequences associated with toe trimming and only one study focused on the innervation of the toes (Gentle & Hunter, 1988). This study was done on broiler breeder males, where the toe usually trimmed is the backward-facing toe, unlike in turkeys, where the three forward-facing toes are trimmed. The degree of similarity of the innervation of the different toes and of the toes in broiler breeders (*Gallus gallus domesticus*) and turkeys has not been investigated, but EFSA experts judge that knowledge from broiler breeders can be applied to turkeys.

Gentle and Hunter (1988) examined the effects of trimming the backward-facing toe in male broiler breeders. The procedure was carried out at a commercial hatchery at the time of hatching, where approximately one-third of the toe was removed by cutting without the use of cautery. Histological examination revealed that toes were well innervated (Gentle & Hunter, 1988), and some nerve regeneration occurred following the trimming. However, in some cases, regenerating nerves became embedded in scar tissue, forming small, localised neuromas that remained throughout the 60-day observation period. The researchers concluded that toe trimming likely causes acute pain during and shortly after the procedure, but that, unlike beak trimming, it is less likely to result in long-term chronic pain. However, in the opinion of EFSA experts, the presence of neuromas, even 60 days after the procedure, is an indication of the possibility of chronic pain. Additional evidence of pain associated with toe trimming comes from a study on turkey toms, including an indication of negative effects on welfare. Fournier et al. (2015) observed that toms, the day after toe trimming, spent more time resting and less time walking, standing or feeding compared to untrimmed toms. Some of these behavioural changes persisted up to 5 days post-procedure, indicating ongoing pain or discomfort. Thus, toe trimming is causing the welfare consequence Soft tissue lesions and integument damage. The trimming of the toes also results in wounds, which may be gateways for bacterial infections. Indeed, high mortality (12.6% during the first week) has been reported in toe trimmed poults (all four toes trimmed at hatch, toes 2–4 by microwave and toe 1 by hot blade), which was believed to be due to bacterial infection of the toe wounds (*Staphylococcus aureus*, isolated from exudate in the hock joints and footpads), causing infection of all four toes, which spread along tendons to joints and bones of the leg, resulting in swelling of feet and hock joints and osteomyelitis of the proximal tibiotarsus (Alfonso & Barnes, 2006). This was a consistent finding among the 200 individuals that were necropsied out of the total 321 dead poults. No treatment consisting of toe-intact toms was included in the study, so no baseline mortality data were available for comparison.

Beyond pain, toe trimming may also impair walking and scratching, indicative of the welfare consequences Locomotory disorder (including lameness) and Inability to perform exploratory or foraging behaviour. Fournier et al. (2015) found both short (as reported in the previous paragraph) and long-term effects of toe trimming on behaviour. Although the reduced activity level following toe trimming decreased with age, by 19 weeks of age, trimmed toms still spent more time standing and less time walking than their toe-intact counterparts (Fournier et al., 2015). Although gait score and bird stance (i.e. body posture) were not affected by treatment, the authors concluded that, based on the changes in the behaviour of the turkeys, both in the immediate period following toe trimming and at the end of the production period, toe trimming causes pain and has negative effects on the balance of the birds. Vinco et al. (2019) found that toe-trimmed turkey hens had higher FPD scores compared to the toe-intact hens. The authors did not record scratching behaviour, but they hypothesised that the higher FPD score could be due to a worse litter quality, which could (partly) result from the lower scratching ability of the turkeys. Fournier et al. (2014) reported that while overall mortality was unaffected by toe trimming, the incidence of mortality attributed to skeletal issues, especially rotated tibia, was higher in toe-trimmed toms compared to those with intact toes (Fournier et al., 2014). These studies provide evidence that toe trimming results in behavioural and skeletal changes that are indicative of the welfare consequences Locomotory disorders (including lameness) and Soft tissue lesions and integument damage.

Fournier et al. (2014) investigated how toe trimming affects body weight and feed consumption at different ages throughout the production period of turkey toms. At weeks 13, 18 and 20, the mean body weight was lower for toe-trimmed than for toe-intact toms. During the first week and the last 2 weeks (weeks 18–19) of production, toe-trimmed toms had a lower feed consumption than toe-intact toms. Toe trimming therefore seems to induce a long-lasting negative affective state associated with the welfare consequence Prolonged hunger, and potentially with the welfare consequence Prolonged thirst, as reduced mobility and activity due to discomfort caused by toe trimming may lead to hindered feeding and drinking behaviour.

3.2.10.4 | *Welfare consequences associated with keeping intact turkeys*

In general, the different types of mutilations are performed to prevent conspecifics from injuring one another when housed under commercial conditions.

3.2.10.4.1 | *Turkeys with intact beaks*

When turkeys are kept with intact beaks (i.e. beak trimming is not conducted), there is an increased risk that injurious pecking may cause more damage to the plumage, skin and tissue of conspecifics than if the turkeys are beak trimmed (Soft tissue lesions and integument damage). The magnitude of the risk may differ between genotypes (see Section 3.2.11.2.2). Generally, beak trimming does not reduce the occurrence of injurious pecking, but rather it diminishes the birds' capacity to grasp, pull and penetrate the integument and other tissues. For example, Denbow et al. (1984) and Leighton Jr. et al. (1985) observed no effects of beak trimming on injurious pecking in turkey toms and hens at 12 and 20 weeks of age. A similar result was found by Cunningham et al. (1992) for turkey toms and hens aged 12 and 18 weeks, though a lower occurrence of agonistic interactions was found in beak-intact hens at 3 and 6 weeks of age, when agonistic behaviour peaked in beak-trimmed hens. On the other hand, (Leighton Jr. et al., 1985) found that beak-trimmed turkey hens performed an increased frequency of feather pecking, including pulling feathers, compared to beak-intact hens at 12 and 16 weeks of age. The authors suggested that the reason for this relates to the reduced ability of beak-trimmed hens to grasp and pull feathers compared to beak-intact hens, under the assumption that they will continue to peck and pull feathers until the act is completed.

Feather pecking and agonistic interactions may occur in both toms and hens, but aggressive pecking (associated with the welfare consequence Group stress) is particularly problematic in toms (Erasmus, 2018; Leishman et al., 2022). Pecks exhibited by males are more forceful and more likely to cause damage (Leishman et al., 2022), as reported in a study conducted by Busayi et al. (2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU)) showing toms to perform stronger feather pecks and pulls at 3 weeks of age compared to hens. Similarly, toms have been found to remove two to three times more feathers than hens at 10 weeks of age, although hens performed twice as much injurious pecking behaviour as toms (Martrenchar et al., 2001).

In a study on two commercial genotypes of turkeys (not further specified), a higher incidence of beak-inflicted injuries was found in beak-intact than in beak-trimmed toms from one of the genotypes, whereas beak trimming had no effect on incidence of injuries in the other genotype (Noble et al., 1994). Improved plumage condition has been found in infrared beak-trimmed 12-weeks-old turkey hens compared to the beak-intact counterparts, whereas beak trimming did not influence the plumage condition of 12-weeks-old toms (Struthers, Fiss, et al., 2022). Four weeks earlier, beak-intact toms had better plumage condition than the beak-trimmed toms, whereas such a difference was not observed in hens.

Bartels et al. (2020) reported that the first occurrence of injurious pecking leading to death in beak-intact turkey toms happened at 41 days of age. However, inconsistent results have been found on the effect of beak trimming on mortality. Denbow et al. (1984) reported reduced mortality for beak-trimmed turkey toms compared to beak-intact toms during week 12 to 20 of age. Likewise, Grigor et al. (1995) reported lower total mortality at 12 weeks of age in groups of beak-trimmed turkey hens than in groups of beak-intact turkey hens, whereas others have failed to find an effect of beak trimming on mortality of either sex (Cunningham et al., 1992; Leighton Jr. et al., 1985; Noble et al., 1994).

A study indicated that at 20 days of age the heterophil/lymphocyte (H/L) ratio, considered a reliable indicator of chronic stress (Bakst & Cecil, 1983), was higher for beak-intact turkeys as compared to infrared beak-trimmed turkeys (Struthers, Fiss, et al., 2022). Based on this, the authors suggested the higher ratio observed in turkeys with intact beaks to be attributed to increased aggression resulting in a stress response. However, they did not find increased injurious behaviour. Instead, it is possible that the pain inflicted during injurious pecking is worse when beaks are intact, and this may have resulted in the higher H/L ratio.

Thus, although beak trimming does not reliably reduce the incidence of injurious pecking, it reduces the severity of injurious pecking lesions.

3.2.10.4.2 | *Turkeys with intact snoods*

Desnooding is performed in toms to prevent trauma, haemorrhage and bacterial infection caused by injurious pecking directed at the snoods (Carver et al., 2002). Details on the results from the two available studies on the effects on welfare of desnooding turkeys can be found in Section 3.2.11.2.1 but in summary one experimental study concluded that keeping toms with intact snood had no effect on mortality and liveweight (Holroyd & Perry, 1971), whereas a later observational field study found an association between desnooding and mortality, with flocks of snood-intact toms having an increased risk of mortality at 7 and 14 days of age (Carver et al., 2002). No further information is provided to explain this result, and no studies examining pecking behaviour directed at the snood in toms during the first 2 weeks of life could be identified, but damaging pecking to wings has been reported to occur as early as the first week of age (Moinard et al., 2001). Although many flocks are kept with intact snoods, both in the EU Member States where beak trimming is conducted and in the EU Member States where beak trimming is banned (e.g. Finland) (EFSA, 2024), no studies have specifically investigated the effect of keeping turkeys with intact snoods on injurious pecking targeting the snood. Haug et al. (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) investigated keeping beak- and snood-intact turkeys under different housing conditions. Based on a clinical examination, they concluded that the snood was the preferred target of injurious pecking. However, the prevalence of turkeys with injurious pecking damage specific to the snood was not reported, as injuries to the head, neck, caruncle and snood were not separately reported. Busatta et al. (2024) reported the distribution across body parts of turkey hens of the total number of lesions caused by injurious pecking from hatch to 62 days of age to be 59.2%, 19.8%, 10.9% and 10.1%, on wing, snood, tail and neck respectively. This was based on a study comparing beak-intact and beak-trimmed turkeys (infrared method), with both treatment groups kept with intact snoods. However, the results were not reported separately for the two beak treatments, although the authors noted that the overall weekly number of injuries was four to six times higher for beak-intact turkeys compared to beak-trimmed turkeys. Based on the experience and knowledge of the EFSA experts, keeping turkeys with intact snoods does not increase the risk of injurious pecking damage to the snood if the turkeys are beak trimmed. However, when turkeys are kept with intact beaks, the risk of injuries increases also in the snood and head areas (Grün et al., 2021; Haug et al., 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt).

3.2.10.4.3 | *Turkeys with intact toes*

The primary reason given for practising toe trimming is to prevent injuries, mainly scratches inflicted by the turkeys' nails on conspecifics (Soft tissue lesions and integument damage). In the case of turkey breeders, toe trimming is also carried out to prevent injuries to handlers during semen collection and artificial insemination.

Indeed, toe trimming applied using microwave trimming has been shown to result in a reduction of scratches observed at processing in 15-week-old turkey hens (Fournier et al., 2012), suggesting this procedure has some benefits for hen welfare. However, Carver et al. (2002) reported that toe trimming of turkey hens did not influence on-farm mortality (no further details provided).

Concerning turkey toms, Fournier et al. (2014) investigated the effects of microwave trimming and found no difference at slaughter (20 weeks) between toe-trimmed and toe-intact toms (genotype: Hybrid Converter) in the proportion of carcasses presenting scratches or other damages. Overall mortality was also unaffected by toe trimming. On the other hand, negative effects of toe trimming were found on body weight at 13, 18 and 20 weeks of age, and toe-intact toms had higher feed consumption during the first and last week of production. It is possible that this was due to the absence of pain in the young, toe-intact toms and a lower prevalence of FPD towards the end of the fattening period. Furthermore, toe-intact toms had a lower mortality caused by skeletal issues, especially a rotated tibia. Based on these results, the authors concluded that toe trimming may not be required or recommended for toms of the heavy genotypes, such as B.U.T 6 and Hybrid Converter. A similar conclusion, irrespective of genotype, could be drawn based on an exercise conducted among focal points and network members of EFSA, which revealed that toe-related injuries in both toms and hens are not a significant concern in the EU member states where toe trimming is not reported to be practised (EFSA, 2024).

3.2.10.5 | Preventive measures to avoid welfare consequences associated with keeping turkeys intact

3.2.10.5.1 | Intact beaks

3.2.10.5.1.1 | Enrichment

As described in Section 3.2.2, providing environmental enrichment has multiple objectives, such as to prevent or reduce abnormal behaviours, reduce negative affective states and increase positive affective states, increase animals' ability to cope with challenges during their rearing and increase the occurrence and variety of species-specific and motivated behaviours. Therefore, providing environmental enrichment will contribute to preventing different types of pecking leading to injuries in turkeys. Enrichment therefore reduces the need for beak trimming.

To prevent welfare consequences linked with keeping turkeys with intact beaks (mainly Soft tissue lesions and integument damage and Group stress due to injurious pecking), the following hazards need to be prevented by the provision of adequate enrichment (for details see 3.2.2): (1) inappropriate, insufficient and absence of elevated structures; (2) inappropriate, insufficient quantity and absence of foraging and exploratory materials; (3) inappropriate, insufficient and absence of visual barriers; (4) inappropriate, insufficient and absence of complex enriched environment with/without covered veranda and (5) inappropriate, insufficient and absence of complex enriched environment with outdoor range. Both point-source objects and more complex enriched environments as described in Section 3.2.2 are needed for addressing those hazards.

Straßmeier (2007) found no injurious pecking in small groups of beak-intact turkey toms kept at very low stocking densities (not specified) and with access to an outdoor run during the fattening period (rearing: group size = 72, replicates 2; fattening: group size = 36, replicates 4; no control groups). According to Straßmeier (2007), the turkeys were able to keep a distance from conspecifics and thereby avoid interactions involving injurious pecking.

3.2.10.5.1.2 | Breeding

Based on direct comparisons between traditional genotypes and modern turkey genotypes, genetic selection against injurious pecking may be a way to reduce the need for beak trimming. In general, injury prevalence tends to be lower among the lighter genotypes. For instance, Olschewsky (2019 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Deutscher Tierschutzbund e.V.) found that Hockenhull Black (light genotype) showed a prevalence of injuries of 28% compared to 37% observed in the heavier genotypes Hockenhull Bronze and Kelly BBB. Similarly, Haug et al. (2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt) found 17.1% injury prevalence in beak-intact Auburn turkey toms (light genotype) and 24.0% injuries in B.U.T.6 turkey toms (heavy genotype) kept under organic farming conditions. In addition, the Auburn turkey toms had less plumage damage in the regions of the wings and cloaca as compared to B.U.T.6 (58.1 vs. 70.8%).

Moreover, a study comparing turkeys of a traditional breed (Nebraska Spot turkeys) with male-line breeder turkeys selected for growth rate and breast meat yield (genotype: N/A) found that the turkeys of the traditional breed did not engage in cannibalistic pecking, unlike turkeys from the commercial genotype (Busayi et al., 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU)). Indeed, 32% of toms and 15% of hens of the commercial male-line genotype required treatment for injuries, whereas no treatment was applied to the traditional breed. However, severe feather pecking was more frequent in the traditional genotype. The lack of injuries caused by injurious pecking among the turkeys of the traditional breed suggests that this breed is more resistant to the effects of severe feather pecking either behaviourally (e.g. the ability of recipients of pecking to move away quickly) or physically (e.g. feathers more difficult to remove or removal causes limited damage and bleeding to the skin), or due to difference in feather structure and feather density (Busayi et al., 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU)). In this context, the traditional breed has been reported to possess higher feather density compared to the modern genotype (Wylie et al., 2003), providing better protection of the skin by decreasing the likelihood of strong pecks reaching the surface of the skin. Therefore, breeding strategies could prevent or mitigate the welfare consequences that may arise with beak-intact turkeys by selecting genotypes less prone to perform injurious pecking and/or genotypes with more resistant integument and higher feather density (see Section 3.2.15 Welfare aspects of genetic and breeding strategies).

Phenotypic variation in beak shape has been examined to explore the possibility of genetic selection to produce morphological results similar to beak trimming. A study by Dalton et al. (2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 5 - EFFAB) assessed the phenotypic variation in turkey beak shape of toms or hens using semi-landmark-based geometric morphometrics (i.e. points defined by extrinsic criteria, commonly used to provide information about the shape of body parts) and determined if this variation is affected by age, sex and beak size. The analysis showed a range of phenotypic variations in the shape of dorsal upper mandibles, lateral lower mandibles and lateral upper mandibles in turkeys at both ages (6 and 18.5 weeks). The obtained results also revealed a sexual dimorphism in beak shape, with hens' upper mandibles appearing wider and blunter dorsally with long, curved beak tips laterally, while toms had narrower beaks with pointed tips. Although only male-line turkeys were examined, the authors concluded that this study provided insights into the possibility of incorporating beak shape variation to select for specific turkey beak phenotypes as an alternative to beak trimming. However, the heritability of beak shape is unknown (EFSA Public call for evidence, 2024, PC 0741, 5 – EFFAB) and industry has declared that despite some efforts being done on this, offering solutions to turkey producers through genetic

selection on beak shape is unlikely to happen in the near future (EFSA Public call for evidence, 2024, PC 0741, 5 – EFFAB). In addition, if selecting for specific beak phenotypes, care should be taken to avoid any negative effects on the function of the beak, potentially impacting behaviours involving the beak, e.g. preening, feeding and drinking behaviour.

3.2.10.5.1.3 | Lighting conditions

Temporary reduction of light intensity is typically used to control outbreaks of injurious pecking. Functional areas with different light intensities inside the barn provide turkeys with a choice, where victims of injurious pecking may seek shelter in the darker areas (Rautenschlein, 2023 AVEC-ELPHA submission of data by email 2025)). Providing light with UV may play a role in prevention of injurious pecking (Sherwin & Kelland, 1998). Additionally, using a light spectrum (6500 K) more similar to daylight than the typical used warm white (3000 K) light spectrum may prevent injurious pecking (Berk et al., 2016). As flicker detectable by turkeys may trigger fear responses and agitation, exacerbating social tension and the welfare consequence Group stress, injurious pecking may be prevented by providing light with flicker above the threshold of what can be perceived by turkeys. However, the precise threshold value is currently unknown. For more information on the association between lighting conditions and injurious pecking, see also Section 3.2.11 on Lighting conditions.

3.2.10.5.1.4 | Space allowance

As described in Section 3.2.3, space allowance may also influence the social interactions between turkeys and thus influence the welfare consequence Group stress, and consequently the welfare consequence Soft tissue lesions and integument damage. The lower the space allowance, the more likely that plumage damage and injurious pecking may occur. Therefore, preventing the hazard 'insufficient space allowance' will help prevent Group stress and Soft tissue lesions and integument damage, especially in beak-intact turkeys. The minimum space allowance to prevent different welfare consequences, including Group stress, is provided in Section 3.2.3 and applies also in this context.

3.2.10.5.1.5 | Natural blunting or smoothing of the beak

Natural blunting or smoothing of the beak (i.e. a process that facilitates beak abrasion through the inclusion of an abrasive material in the feeder or using abrasive enrichment devices such as pecking stones) has been tested as an alternative to beak trimming in laying hens (Struthers, Buchynski, et al., 2022), Japanese quail (Taskin & Camci, 2017) and turkeys (Grün et al., 2019; Grün et al., 2021). Grün et al. (2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Four Paws) evaluated the effectiveness of grinding wheels (blunting disks) that were fitted in the feed pans of 6-week-old, non-beak trimmed turkey toms of three genotypes (B.U.T. 6, B.U.T. Premium and Auburn), as an alternative to infrared beak trimming. Their results showed a noticeable beak abrasion in birds provided with blunting disks and no difference in terms of injuries and plumage condition as compared to the beak-trimmed turkeys. At 19 weeks of age, irregular alterations of the bone (praemaxillary) and neuronal proliferations were observed in the beaks of all examined beak-trimmed turkeys, whereas no negative alterations due to the blunting method were detected. The provision of such material could be a promising method to prevent long-term pain and the welfare consequence Soft tissue lesions and integument damage resulting from the beak trimming procedure, but dedicated management is required to reach the optimum level of blunting, as too efficient blunting may result in welfare consequences similar to those caused by beak trimming, whereas inefficient blunting will result in Soft tissue and integument damage if injurious pecking develops. The management involves the correct choice of blunting material and/or level of feed pan filling, as well as continuous monitoring of beak shape, plumage and integument. It is worth noting that this preventive strategy does not address the underlying cause leading to injurious pecking, but similar to beak trimming, only reduces the risk of damage inflicted when injurious pecking occurs (Figure 7).



FIGURE 7 Feed pans without the blunting material (left) and with integrated abrasive material (right) (Grün et al., 2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Four Paws) © Grün et al. (2021).

3.2.10.5.2 | *Intact snoods*

Desnooding is performed to prevent welfare consequences resulting from injurious pecking directed at the snood. Therefore, strategies to avoid the need for desnooding focus on preventing injurious pecking and/or minimising the damage it causes, especially in beak-intact turkeys. As a result, the preventive measures outlined for beak trimming in Section 1.4.1 are also applicable to desnooding. For example, Grün et al. (2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Four Paws) compared non-beak-trimmed turkeys housed with blunting disks with beak-trimmed turkeys of three different genotypes, and found that for the Auburn turkeys, beak treatment did not influence the risk of injuries to the snood. However, this was not the case in B.U.T. Premium and B.U.T. Six turkeys, where beak-intact turkeys housed with blunting disks had a higher risk of snood injuries than beak-trimmed counterparts.

Additionally, one potential preventive approach is genetic selection for a reduced snood size. However, no studies have evaluated the effectiveness of this strategy or investigated the heritability of snood size.

3.2.10.5.3 | *Intact toes*

Preventing the need for toe trimming can be achieved through some of the same strategies used to prevent beak trimming. These include environmental enrichment, appropriate lighting conditions, adequate space allowance and the use of devices that blunt, smooth or shorten the claws.

Enrichment can help prevent inability to perform exploratory or foraging behaviour, which may reduce the development of injurious pecking and subsequent plumage damage (see Section 3.2.2: Enrichment). Maintaining intact plumage is important, as it provides protection against scratches and wounds caused by intact toes (see also Section 1.4.1.3 on feather density as a preventive measure (Busayi et al., 2006 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Compassion in World Farming Brussels (CIWF EU))).

Lighting where the flicker is not detectable by turkeys can help prevent Soft tissue lesions and integument damage caused by intact toes, because flicker may trigger fear responses and agitation, which may exacerbate social tension and the welfare consequence Group stress, resulting in increased risk of scratches caused by the toes of conspecifics (see also Section 3.2.11 on Lighting conditions).

Higher stocking densities have been associated with an increased risk of bird-to-bird disturbances in turkeys (Martrenchar et al., 1999) and broiler chickens (Dawkins et al., 2004; Hall, 2001; Ventura et al., 2012). While the impact of such disturbances on turkey productivity and carcass quality remains to be fully investigated, studies in broiler chickens have linked increased disturbance to reduced carcass quality due to bruising and scratching (Cornetto et al., 2002).

The rationale behind the use of claw-shortening devices is similar to that of beak-blunting tools. Experience with laying hens has shown that such devices, including abrasive strips and ceramic plates, are effective in shortening claws and maintaining good plumage and skin condition (Roll et al., 2008). Therefore, similar devices may be considered as alternatives to toe trimming in turkey production, although further research is needed to confirm their effectiveness and the optimum level of blunting.

3.2.10.6 | *Mitigation measures to alleviate the welfare consequences caused by mutilations*

The mitigation measures available for alleviating the welfare consequences caused by mutilation are similar for beak trimming, toe trimming and desnooding. These include choosing the least harmful mutilation method, using locally applied anaesthesia and performing the intervention at as early an age as possible.

A number of studies have compared the resulting welfare consequences from different beak trimming methods, and infra-red beak trimming has been reported to have overall least negative impact on poultry welfare (for a comparison of beak-trimming methods, see EFSA AHAW Panel, 2023b). No such comparisons have been made for toe trimming or desnooding methods.

Studies have shown that analgesics (carprofen, benzocaine) alleviate the pain experienced following hot-blade beak trimming (Glatz et al., 1992; Najafpour, 2008), whereas other authors found no effect (Freire et al., 2008). Alfirevich et al. (2025) investigated the effect of different dosages of the analgesic meloxicam on the behaviour of turkey poults that were either only infra-red beak-trimmed or exposed to infra-red beak trimming, toe trimming and desnooding. A control treatment, where poults were kept intact, was not included. A clear meloxicam dose-response was not found. No other studies have been found on the use of analgesics in connection with the mutilations performed in turkeys, but the EFSA experts judge, that if the analgesic is administered correctly (i.e. effective type, dose, timing) pain relief may be experienced for all types of mutilations performed and methods applied. There is a lack of knowledge on how effective locally applied anaesthesia is to prevent the pain due to the Soft tissue lesions and integument damage caused by beak trimming.

There is consensus based on existing knowledge that the welfare consequences of beak trimming are more severe if the procedure is applied to birds older than those newly hatched (EFSA AHAW Panel, 2023b; Freire et al., 2008; Janczak & Riber, 2015). Knowledge on this aspect could not be found for toe trimming and desnooding, but the EFSA experts judge that the same principles are likely to apply for these types of mutilation. It could be argued that performing mutilations at a later age allows the turkey to live part of its life without the welfare consequences associated with these procedures. Conversely, it may be counterargued that turkeys mutilated immediately after hatching have never experienced life without the associated discomfort, as this becomes their norm, and therefore the impact may be less negative compared to

older turkeys, who have experienced life with an intact body. The EFSA experts concluded that mutilation of day-old poult results in fewer associated welfare consequences compared to mutilation at later ages.

3.2.11 | Lighting conditions

3.2.11.1 | Background

Light intensity, spectral composition and photoperiod are factors that affect the biology of turkeys across all ages and production systems. Light regulates circadian rhythms, feeding and drinking behaviour, activity levels, social interactions and resting patterns (Schwean-Lardner et al., 2016). It also enables turkeys to visually explore and interact with their environment, which is particularly important given their reliance on vision above other senses (Prescott et al., 2003). Commercial turkey production systems rely heavily on artificial lighting to manage behaviour, growth and reproduction, except for the systems where curtains are installed (providing regulated access to natural light when open) or for systems with outdoor range access.

Turkeys possess a highly developed visual system, with relatively large eyes and four classes of cone photoreceptors sensitive to long (564 nm), medium (505 nm), short (460 nm) and violet (420 nm) wavelengths, enabling tetrachromatic vision extending into the ultraviolet-A (UV-A) range (Hart et al., 1999). Studies indicate that turkeys prefer environments with UV-A light (Moinard & Sherwin, 1999), and UV-A reflective plumage markings (Bartels & Berk, 2017) are associated with the onset of feather pecking (Sherwin & Devereux, 1999).

The effects of lighting conditions on turkey welfare are influenced by both age and earlier life experiences. Experimental work has shown that the light intensity experienced early in life shapes subsequent preference. In a choice test, turkeys reared under dim conditions at 4 lux later preferred environments at around 5 lux, whereas birds reared under 12 lux showed a marked preference for brighter conditions, up to 25 lux (Sherwin, 1998). This demonstrates that rearing history influences perception of light, thereby influencing behavioural responses, and indicates that hazards associated with both very low and very high intensities may vary with age and experience.

Regarding light intensity, it should be noted that turkey lighting studies continue to report light intensity in the human-based measuring unit 'lux', although this unit describes brightness from the human visual perspective and not the avian one (Barber et al., 2006). In laying hens and broiler chickens, the *gallilux* unit was developed to reflect light intensity as perceived by the chicken (*Gallus gallus domesticus*) and better align lighting conditions with their visual physiology (Nuboer et al., 1992). This chicken-specific measure accounts for differences in spectral sensitivity, including the ultraviolet range, which human vision does not detect. In turkeys, the same challenge exists: the use of the conventional lux scale is considered unsuitable for evaluating light intensity in turkey barns because it reflects human perception only (Kämmerling et al., 2017; Kämmerling et al., 2018). It is currently unclear whether the same spectral weighting curve is fully appropriate for turkeys. While turkeys share general avian visual features, including ultraviolet sensitivity, species-specific calibration may be required, and no validated turkey-specific lux system exists at present. It has been highlighted that the lack of turkey-specific light measurement tools limits precision in welfare-based lighting design, despite evidence that turkeys respond behaviourally and physiologically to different light intensities and spectra (Lindenwald et al., 2018; Berk et al., 2016).

As light affects numerous aspects of turkey physiology and behaviour, inappropriate lighting conditions, including unsuitable intensity, photoperiod, spectral composition and flicker, can lead to a range of welfare consequences such as Group stress, Soft tissue lesions and integument damage, Resting problems, Locomotory disorders (including lameness), Restriction of movement, Inability to perform exploratory and foraging behaviour, Prolonged hunger, Eye disorders and Sensory under- and/or overstimulation. The following sections summarise key hazards and their associated welfare outcomes.

3.2.11.2 | Hazards linked with lighting conditions and associated welfare consequences

3.2.11.2.1 | Too low light intensity

Management of light in turkey production often aims to reduce injurious pecking (Group stress and Soft tissue lesions and integument damage) by lowering light intensity, in some cases to 1 lux or less. However, such low levels have been shown to be aversive for turkeys (Sherwin, 1998) and are associated with ocular abnormalities (welfare consequence Eye disorders) (Harrison et al., 1968), leg problems (welfare consequence Locomotory disorders (including lameness)) (Classen et al., 1994; Hester et al., 1987), increased adrenal weight (Siopes et al., 1984), reduced activity and feed intake (welfare consequences Restriction of movement and Prolonged hunger) (Hester et al., 1987), and difficulties for stockpersons in monitoring birds (Appleby et al., 1992; Manser, 1996). Sherwin (1998) demonstrated that birds consistently avoided 1 lux chambers, spending little time there and feeding less compared with brighter options ranging from 5 to 25 lux. Therefore, if maintained in such lighting conditions, birds may be exposed to the welfare consequence Prolonged hunger.

Consistent with this evidence, the Council of Europe (2001)¹⁷ recommends maintaining light intensities of at least 10 lux for turkeys during periods when the house is lit, with lower levels permitted only temporarily when required to manage injurious pecking. Some national regulations (e.g. Denmark) require ≥ 20 lux in most of the barn (BEK nr 1748 af 30/11/2020¹⁸), but this goes beyond the recommendations of the Council of Europe for minimum light intensity and does not rely on available scientific evidence.

Prolonged periods of dim light can cause understimulation, inactivity and frustration (Sherwin, 1998). This mismatch between turkeys' visual ecology and barn environment contributes to the welfare consequence Sensory under- and/or overstimulation.

3.2.11.2.2 | *Too high light intensity*

The activity level of turkeys increases at light intensities above 25 lux, including time both spent feeding and performing aggressive behaviour (Classen et al., 1994; Hester et al., 1987). Studies by Classen et al. (1994) and Hester et al. (1987) found increased injurious pecking and social tension under such light intensities. This highlights the importance of appropriate enrichment and sufficient space as preventive measures, as without that, the risk of welfare consequences such as Group stress, Soft tissue lesions and integument damage, and Resting problems is exacerbated. If injurious pecking develops under high light intensity, a mitigation measure is to temporarily reduce light intensity (Sherwin, 1998) and extra focus on preventive measures is warranted in the following flocks.

Skiba et al. (2024) proposed that the bright patches of light falling through gaps of the side walls in some types of barns can induce restlessness or injurious pecking. As a preventive measure, they suggested to instal structural elements to reduce bright patches and create diffusion of the day light.

Modern turkey production increasingly recognises the importance of providing functional areas with different light intensities inside the barn. Creating brighter areas for active behaviour and darker areas for resting behaviour supports natural behaviour by allowing turkeys to select environments suited to their behavioural motivation. Field data from German commercial farms showed that over 90% of the 200 transponder-marked turkeys voluntarily used the darker areas and primarily rested there (Rautenschlein, 2023 AVEC-ELPHA submission of data by email 2025)). Light intensity was reduced at least 30% in the resting areas, which comprised a minimum of one-eighth of the total floor area. In addition, injurious pecking behaviour (head and body) was found to occur less frequent in the resting areas compared to the brighter areas on most farms (Rautenschlein, 2023 AVEC-ELPHA submission of data by email 2025)).

In the absence of evidence on how light conditions affect the welfare of turkey breeders, it is reasonable to assume that the main lighting-related risk factors identified for meat turkeys also apply to breeding stock. However, the relative importance of these hazards may differ between production stages. Because adequate light intensity plays a key role in regulating reproductive physiology and sexual behaviour in turkeys, breeder flocks are less likely to be exposed to prolonged periods of very low lighting compared to meat turkeys (see Section 3.2.12 The practice of artificial insemination). As a result, the severity and/or presence of welfare consequences associated with insufficient light levels may be comparatively lower in breeders. Conversely, excessive light intensity may represent a more critical welfare challenge for breeder turkeys.

3.2.11.2.3 | *Inappropriate photoperiod and lighting programmes*

The photoperiod is a major environmental cue for the regulation of circadian rhythms and reproductive physiology in birds (Liddle et al., 2022). In turkeys, lighting schedules, such as constant light, insufficient duration of dark periods or abrupt changes in light duration, has been shown to influence behavioural patterns including resting, feeding and social interactions, which are crucial for maintaining normal circadian rhythms and welfare (Millam, 1987). Such light disruptions are associated with increased restlessness, difficulty in initiating or maintaining rest and altered pre-laying and nesting behaviour (welfare consequences Resting problems and Inability to express pre-laying and nesting behaviour). Insufficient dark periods may also lead to the welfare consequence Eye disorders. Turkey blindness syndrome, characterised by chorioretinitis and retinitis, is caused by exposure to 24L and 23L:1D over 8 weeks (Davis et al., 1986). Turkeys exposed to 23L:1D had a higher prevalence of cataracts than turkeys exposed to 14L:10D for 18 weeks (Leis et al., 2017).

Unlike turkeys kept for meat production, turkey breeders remain on farm for about 59 weeks and are exposed to lighting programmes specifically designed to regulate the reproductive cycle. The photoperiod is manipulated to control the onset of lay, often through step-up increases in day length and light intensity. If these changes are abrupt rather than gradual, they can induce signs of stress and disrupt circadian rhythms, leading to the welfare consequence Resting problems (Millam, 1987; Sherwin, 1998). Long duration or even constant exposure to light is sometimes applied to maximise egg production, but these regimes reduce undisturbed rest and have been associated with the welfare consequence Group stress (Classen et al., 1994; Hester et al., 1987). In contrast to meat turkeys, which are typically reared on longer photoperiods (e.g. 20–23 h light during early rearing, tapering to ~14–18 h), breeder turkeys are reared on short days (≈ 8 h light) to prevent premature sexual maturation and later photostimulated with longer days (≈ 14 –16 h light) to initiate reproductive

¹⁷<https://www.coe.int/en/web/cdcj/2001-rec-turkeys>.

¹⁸Ministry of Food, Agriculture and Fisheries of Denmark, BEK no. 1748 of 30/11/2020 Executive Order on minimum animal welfare requirements for keeping turkeys for slaughter <https://www.retsinformation.dk/eli/ta/2020/1748#:~:text=BEK%20nr%201748%20af%2030%2F11%2F2020,-Ministeriet%20for%20F%C3%B8devarer&text=%C2%A7%201.,der%20holdes%20til%20erhvervsm%C3%A6ssigt%20form%C3%A5l>.

activity. Any disruptions of these schedules, such as insufficient dark periods, continuous light or abrupt changes in day-length can disturb rest and circadian stability, resulting in fatigue, increased arousal and stress reactivity and behavioural instability (Appleby et al., 1992; Manser, 1996), which may indirectly increase the risk of the welfare consequences Soft tissue lesions and integument damage (from mounting) and Handling stress (from increased reactivity during handling) (Appleby et al., 1992; Manser, 1996).

3.2.11.2.4 | *Inappropriate light spectrum composition (UV-A absence)*

Most artificial lighting systems used in commercial turkey production emit negligible UV-A radiation, which is a significant hazard, given turkeys' visual sensitivity to this spectral range (Hart et al., 1999). By contrast, natural light contains UV-A wavelengths, and access to natural light or lighting systems supplemented with UV more closely replicates the natural visual environment. Absence of UV impairs social communication by obscuring plumage signals. Moinard and Sherwin (1999) showed that turkeys preferred UV-illuminated environments. Sherwin and Devereux (1999) demonstrated that poults develop UV-visible plumage markings around the age when feather pecking typically begins, and that rearing birds without UV light was associated with increased feather pecking, suggesting that UV perception may play a role in social recognition and injurious pecking behaviour. This was later confirmed by Berk et al. (2016), who also reported that UV-visible feather patterns emerge at the age when pecking typically begins, suggesting that visual cues, rather than UV light itself, may influence pecking responses. However, the precise relationship between UV provision and injurious pecking in adult birds remains unclear (Dalton et al., 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)).

The absence of UV-A therefore disrupts social signalling and contributes directly to the welfare consequences Group stress and Soft tissue lesions and integument damage. Sherwin (1998) also found that artificial light with UV, particularly when combined with environmental enrichment, reduced injurious pecking and improved feather condition. Moreover, artificial light without UV contributes to the welfare consequence Sensory under- and/or overstimulation by depriving birds of key visual cues. Access to natural daylight or UV-supplemented artificial light can therefore reduce feather pecking by supporting normal visual perception and social signalling.

Berk et al. (2016) reported a higher prevalence of injurious pecking in pens illuminated with warm-white lighting (3000 K) compared with daylight-like tubes (6500 K), suggesting that spectral composition may influence pecking behaviour. The authors also observed that young turkeys preferred higher light intensities (> 20 lux), regardless of light spectrum. Thus, both age and light spectrum appear to modulate behavioural responses to lighting, although the relative contribution of spectral characteristics versus intensity remains not entirely clear.

Access to natural light presents both potential benefits and risks for turkeys. Recent work has indicated that providing natural light, in combination with artificial supplemental light, can improve feather cover and support optimal ocular development in turkeys compared with rearing under artificial light alone (Bartz & Grimes, 2021). However, this does not imply that artificial lighting necessarily impairs eye development; rather, daylight exposure appears to provide additional visual and physiological benefits.

3.2.11.2.5 | *Flickering*

Turkeys have a higher critical flicker fusion frequency than humans, enabling them to detect flicker in light sources that appear continuous to the human eye. Studies of laying hens (*Gallus gallus domesticus*) have reported the thresholds for conscious perception of flicker to be between 90 and 105 Hz (Jarvis et al., 2002; Lisney et al., 2012; Nuboer et al., 1992) and unconscious perception (measured as a physiological response) to be 118 to 119 Hz (Lisney et al., 2012). Similar threshold values have not been determined for turkeys. Broiler chickens (*Gallus gallus domesticus*) subjected to flicker at 100 Hz expressed inhibited activity (number and intensity of movements) compared to those subjected to high flicker frequency (26,000 Hz) (Boshouwers & Nicaise, 1992). In turkey hens, Hammond et al. (2024) found that a flicker frequency of 30 Hz reduced some comfort and exploratory behaviours early in life (4 and 8 weeks of age), with the impact on preening continuing to 10 weeks of age, compared to flicker frequencies of either 90 or 195 Hz. However, some behaviours, as well as stress (H/L ratio) and fear responses (novel object test), were unaffected by flicker frequency. This demonstrates that exposure to perceptible flicker may have a sensory impact, contributing to the welfare consequence Sensory under- and/or overstimulation. This may exacerbate social tension, resulting in the welfare consequence Group stress, and potentially increase the risk of injurious pecking and scratches from nails of conspecifics, further linking this hazard to the welfare consequences Soft tissue lesions and integument damage.

3.2.11.3 | *Preventive and mitigation measures*

Light management in turkey housing is planned in advance before birds arrive, but also requires ongoing adjustments throughout the production cycle. Because changing lighting conditions can both prevent welfare hazards and help mitigate them if they arise, preventive and mitigation actions are considered together in this section, except for those addressing UV-A.

The installation of UV-A lighting is a preventive approach designed to ensure that appropriate spectral conditions are already in place once the visual signalling features on the plumage emerge around 7 days of age. Installation of a light

source emitting UV-A radiation should be in place before the start of the production cycle. During the production cycle, any modifications in the light installations due to practical constraints and bird safety are largely impossible, except for urgent situations. Where natural light is not available, artificial lighting systems which include UV-A wavelengths matching turkeys' visual sensitivity can be applied to support social signalling (Hart et al., 1999; Sherwin & Devereux, 1999).

Light intensity can be maintained within a range that allows normal behavioural time budget, minimises aggression and allows full inspection of birds. Prolonged exposure to less than 5 lux is associated with ocular pathology, reduced activity and impaired farm welfare inspections (Harrison et al., 1968; Hester et al., 1985; Sherwin, 1998; Siopes et al., 1984). 'Too high light intensity' is not a hazard per se, since the associated welfare consequences Group stress and Soft tissue lesions and integument damage can be prevented when other measures addressing enrichment provision and adequate space allowance are applied (Classen et al., 1994; Hester et al., 1987). Adequate space allowance and enrichment prevent Group stress and Soft tissue lesions and integument damage, regardless of the light intensity.

Preventive management includes the provision of a stable daily light–dark cycle, with adequate dark phases to maintain circadian rhythms (Millam, 1987). Adjustments should involve a gradual and predictable step-up or step-down schedule. In addition, lighting installations should ensure even light distribution, minimise glare and provide no perceptible flicker to prevent the associated welfare consequences. It is important to routinely check light levels and spectral composition at bird-eye height across different locations in the barn. Preventive strategies are most effective when integrated with other management measures known to reduce the risk of injurious pecking, such as provision of environmental enrichment, particularly in combination with UV-A light (Moinard & Sherwin, 1999; Sherwin, 1998). Light shading may be used to establish functional areas in the house to create dark areas for resting and brighter areas for active behaviour.

When welfare consequences linked to lighting have already appeared, lighting equipment and schedules can be reconfigured or replaced with systems fulfilling turkey light requirements. Light diffusers and shading may be useful in reducing bright spots or glare (Skiba et al., 2024).

3.2.12 | The practice of artificial insemination

3.2.12.1 | Background

In heavy and medium weight genotype turkeys, natural mating is problematic due to the difference in body size between toms and hens, leading to lower fertilisation in heavy, broad-breasted genotypes (Taye & Esatu, 2022). As a side-effect of genetic selection for heavy and broad-breasted turkeys, whose toms have problems to transfer semen to the hens at copulation (Bakst & Dymond, 2013; Glatz & Rodda, 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Djurens Rätt) Artificial insemination (AI) has become the standard procedure since the 1960s for the commercial production of turkeys of conventional genotypes (no heritage turkeys) (Bakst & Dymond, 2013; Donoghue & Wishart, 2000; Marks, 2017). Artificial insemination is applied also to reduce the risk of injuries and the associated risk of infection in hens due to sharp claws of the toms during copulation (Marks, 2017; VKM, 2016). A productive advantage of AI is the smaller number of toms required to be kept for collecting the semen compared to the number of toms necessary if natural mating were used. AI causes welfare consequences to toms during the semen collection and hens during the insemination procedure (Donoghue & Wishart, 2000; Taye & Esatu, 2022).

The practice of AI has been described in the technical report (EFSA, 2026). Limited scientific literature is available on the impact of semen collection and insemination procedure on the welfare of turkey breeders. Few studies examined these practices from the point of view of reproduction and production practices. Furthermore, the limited literature is focused on these practices in parent stock, while no literature shows the practices applied, nor their link to welfare, in grandparents and older generations. The EFSA experts assume comparable practices in grandparent and earlier generations; therefore, the assessment applies to those groups too.

3.2.12.2 | Collection of semen

In the laying farms, turkey toms are manually ejaculated three times per week during the first week of semen production at 28 to 30 weeks of age, and in the following weeks once per week until the end of the cycle (Hendrix genetics, 2023). The cycle lasts up to 28 weeks (see EFSA, 2026; Hendrix genetics, 2023). Even if semen is not needed, all toms will be ejaculated at least once a week to maintain good semen quality. The collection of the semen includes handling by farm operators. There are two methods of handling for collection of semen from the toms, namely bench and floor, which can be carried out by one or, usually, two operators. In the bench system, the operator fixates the tom on the back, and a mechanical clamp may be used to fix the legs. During the semen collection, the farm operator massages the cloacal region, and then a cloacal stroke is applied to depress the region around the sides of the cloaca (Bakst & Cecil, 1983). In the floor system, one operator holds the turkey tom and the second one massages the cloacal region and collects the semen (which may also be collected by a third operator). The ejaculate is obtained through the manual stimulation of the cloaca. Breeder guides advise that careful handling of the toms is applied to reduce the risk of injuring the birds during semen collection. Care is taken to avoid contamination of semen with faeces, uric acid or transparent fluids (Senchuri et al., 2025); this practice has implications for animal welfare because the higher the semen quality and the insemination success, the less the toms and the hens have to be handled. The quality of the collected sperm is periodically analysed on farm (Hendrix genetics, 2023).

Insemination of turkey hens

The first AI of turkey breeder hens typically occurs between 28 and 30 weeks of age, depending on the genetic line and onset of photostimulation. For medium lines, insemination takes place approximately 14–16 days after the increase in day length, and for heavy lines, after 18–19 days or more (Aviagen Turkeys, 2023b). This schedule is based on overcoming juvenile photorefractoriness – a physiological state in which the reproductive system remains unresponsive to light stimuli until maturity. The timing of photostimulation and insemination is further detailed in EFSA (2026).

Squatting behaviour is considered a manifestation of sexual maturity by the turkey hens and an indicator of readiness for the first insemination. At least 95% of the hens should be laying their first egg either the day before or on the day of the first insemination.

Prior to insemination, the turkey breeder hen is caught and, depending on the method used, will be turned on her back (e.g. bench method) or not if a pit or ramp is used. Pressure is then applied to the cloacal region of the hen, and the cloaca is stimulated to protrude by means of an insemination tube (Hafez & Hafez, 2000). A minimum of 0.025 mL of semen is deposited with a pipette inserted 2.5 cm into the female's everted vagina, allowing spermatozoa to be deposited close to the sperm host (or sperm storage) glands, where they can survive for up to 3 weeks or longer (Singh, 2023). Insemination of hens is performed three times during the first week, followed by one insemination per week thereafter up to 28 to 30 weeks in total (Aviagen Turkeys, 2023b; Hendrix genetics, 2023; Jong & Swalander, 2012). Insemination takes place in the afternoon or evening when there are normally no hardshell eggs in the uterus (Donoghue & Wishart, 2000; Getachew, 2016; Senchuri et al., 2025).

3.2.12.3 | Hazards linked with the practice of artificial insemination and associated welfare consequences

AI in turkeys presents several welfare challenges, primarily related to handling, timing of first insemination of the hens and procedural technique, as well as risks during the peri-procedural period associated with corralling and penning. Due to this, AI of hens and semen collection in toms is associated with the welfare consequences Handling stress, Bone lesions, Soft tissue lesions and integument damage, Prolonged hunger, Reproductive disorders and Group stress. Due to the restraining of the tom or the hen, they cannot avoid the semen collection nor the insemination practice, which may add additional welfare or healthy concerns.

Handling involves moving, catching and restraining the toms and hens, placing each bird in a fixed position and performing semen collection and insemination.

Toms

Femoral fractures resulting from inappropriate handling were identified as an animal-based measure (ABM) in tom breeder flocks that result from overuse due to repetitive handling, skeletal overload from excessive body weight or a combination of both (Crespo et al., 1999). Twice-weekly handling for semen collection was suggested to induce tensile and bending stresses in the bones of the hind limbs and thus result in the welfare consequence Bone lesions. However, this publication was based on a case study and the correlation between handling for semen collection and fractures was not directly investigated (Crespo et al., 1999).

Catching and restraining toms can cause physical harm and/or negative valence. Crowding and/or fighting among toms can lead to Group stress and may result in Soft tissue lesions and integument damage caused by other birds, equipment or the farm operators. The heavy live weights of toms and the distance to the place of semen collection may also require the birds to be trailed (for a short distance). Depending on the characteristics of the ground surface and staff training, this may lead to wear and tear of the plumage. The weight and potential struggling of toms can also damage the legs or wings if caught incorrectly, leading to the welfare consequence Bone lesions. If a mechanical clamp is used to restrain the birds, struggling or a clamp malfunction may cause pain and/or harm to the birds (VKM, 2016). If a mechanical clamp is used to restrain the birds, struggling or a clamp malfunction may cause pain and/or harm to the birds (VKM, 2016).

Bakst and Cecil (1983) examined the cloaca of toms before and after single and multiple semen collections. The authors reported that all cloacae exhibited some degree of haemorrhage, the extent of which depended on the frequency of semen collection, the number of cloacal strokes and individual differences between semen collection techniques. In toms subjected to a single routine semen collection with one cloacal stroke, cloacal haemorrhages were less extensive than in other groups and only limited to petechiae on the caudal margin of the dorsal proctodeum.

Lighting programmes can influence tom behaviour during semen collection, which affects both handler safety and animal welfare. Toms exposed to a 16L:8D light schedule from 10 weeks of age showed reduced struggling and were easier to handle compared to those kept on a 6L:18D schedule until 29 weeks (Noonan & Bacon, 2000). Excessive struggling during handling can increase the risk of injury and stress. The assessment of struggling was based on a scoring system ranging from 0 (no struggle) to 3 (intense wing flapping; described in details in Noonan (Noonan, 1999)).

To avoid semen contamination by urates and faeces during semen collection and artificial insemination, the toms are fasted before the procedure. Industry guidelines recommend fasting for 4–6 h before semen collection (Bauman, 2018). However, there is no scientific research that shows that feed restriction for 4–6 h reduces faecal and urate contamination in collected sperm. According to Duke et al. (1997), a 4-h feed and water withdrawal is sufficient to empty the gastroenteric tract of turkeys and thereby minimise the risk of semen contamination with faeces during collection. Extending feed

withdrawal beyond 4 h does not further reduce gastrointestinal content but increases the risk of welfare consequences. The toms may experience Prolonged hunger, and post-restriction toms will potentially experience Group stress linked with fighting to access the feeder (VKM, 2016). Furthermore, based on research conducted in broiler breeders, the longer the feed withdrawal, the higher the frustration (Puterflam et al., 2006), which could lead to Group stress. Poultry subjected to feed withdrawal periods longer than 6 h will exhaust crop feedstores and liver glycogen reserves, and therefore the AHAW Panel concluded with 50%–100% certainty that they will experience Prolonged hunger after this time period (EFSA AHAW Panel, 2022a).

Breeder toms are housed in small groups of approximately 16–30 birds (European Commission, 2024a). If toms are moved between pens while they are being caught and restrained during the semen collection practices, it may increase head pecking and aggression due to disruption of established social hierarchies, leading to Group stress and Soft tissue lesions and integument damage. Buchwalder and Huber-Eicher (2003) showed that the introduction of a tom for 30 min into groups of five toms resulted in more aggressive interactions directed towards the unfamiliar conspecific than towards the familiar group members, suggesting that group stability and social recognition are important factors in minimising aggression and the associated welfare consequences.

Hens

In hens, improper or rough handling such as lifting birds by a single leg or applying excessive force results in Handling stress.

Another important welfare consideration is the timing of the first insemination. Additionally, if the hymen is still intact, the forceful insertion of the insemination tube can result in cloacal wounds and infections, leading to the welfare consequences Soft tissue lesions and integument damage and Reproductive disorders (Hendrix genetics, 2023). Performing insemination too early, before the reproductive tract is fully developed, can damage the oviduct and cause pain, leading to Soft tissue lesions and integument damage and Handling stress. In addition, this may lead to Reproductive disorders due to infection of the oviduct and egg peritonitis (Aviagen Turkeys, 2023b; Kosonsiriluk et al, 2023).

Additionally, Soft tissue lesions and integument damage and Handling stress may occur if the tube is inserted in the reproductive tract with too much force. The Norwegian Scientific Committee for Food Safety has assessed the welfare impact of AI, identifying tissue damage and haemorrhage from forceful insertion of the insemination tube as a moderate welfare risk (VKM, 2016).

While cloacal tissues generally return to a near-normal macroscopical appearance within 3 days post-insemination, confirming this requires histological post-mortem examination, making it unsuitable as a practical ABM on farm. Notably, there is a lack of recent studies on the current prevalence of cloacal haemorrhage in toms and hens in commercial settings.

3.2.12.4 | Preventive and mitigation measures

AI and semen collection, while essential for reproduction in heavy- and medium-weight conventional turkey lines, constitute an inherent hazard to welfare due to the handling and invasiveness of the procedures. Yet currently, no viable alternative exists, and the practice cannot be prevented. However, correct timing of the first insemination (after 95% of hens are ready to lay and show squatting behaviour) can prevent oviduct damage and subsequent infection causing Reproductive disorders.

By reducing the associated hazards, particularly those related to handling and the technique used, the welfare consequences caused by AI can be mitigated.

Flock-level monitoring can be applied for early detection of welfare consequences associated with AI. This includes monitoring behavioural changes such as altered responses to handling, reduced squatting behaviour, signs of pain and distress or production anomalies (changes in semen quality, fertility or drops in egg production) and cloacal inspections.

When the same, trained farm operator performs semen collection and insemination procedures consistently throughout the production cycle Handling stress can be mitigated. Turkeys can habituate to specific handlers over time, which can reduce their stress response during repeated handling. Familiarity with the handler's movements, voice, clothes and approach can lead to calmer behaviour in both toms and hens, improving animal welfare and reducing the risk of injury to both turkeys and staff. Conversely, frequent changes in personnel may increase Handling stress indicated by bird agitation, resistance during restraint and handling-related injuries. Using proper equipment (e.g. mechanical clamps in good condition) and adhering to consistent procedures further reduces the risk of injuries. Preparation for semen collection, stimulation and semen collection require calm and professional handling of the toms by the farm operators (Bauman, 2018). Optimal lighting programmes can reduce struggling during semen collection (Noonan & Bacon, 2000).

As demonstrated by Buchwalder and Huber-Eicher (2003), toms show significantly more aggression towards unfamiliar individuals in small groups. Therefore, moving toms between pens when caught for semen collection disrupts established social hierarchies, leading to Group stress and increased aggression. Aviagen Turkeys (2023c) advise against regrouping toms for this reason. Maintaining fixed group compositions helps prevent injuries, stress and social instability among breeder toms.

Additionally, minimising feed withdrawal of the toms before semen collection, if employed, to a maximum duration of 4 h, prevents Prolonged hunger, Group stress and Soft tissue lesions and integument damage due to competition and aggression when toms regain access to feed. Where feed withdrawal is practised, post-withdrawal management (e.g.

controlled re-feeding, provision of unrestricted access to resources) can help reduce Group stress and Soft tissue lesions and integument damage.

3.2.13 | The practice of feed restriction

3.2.13.1 | *Description of the practice of feed restriction under feed control programmes*

Feed control programmes are applied during the rearing phase to toms and hens to control their body weight, enhance reproductive performance and synchronise sexual maturity, and during production in toms to adjust the body weight trajectory and maintain semen production (Aviagen Turkeys, 2025a, 2025b; Hendrix genetics, 2023). Some of these feed control measures include feed restriction when turkeys are overweight, whereas it can consist of increasing the growth rate if turkey flocks are underweight compared to the target weight. The latter will not be assessed in this section, as it is not related to feed restriction.

In turkeys, two forms of feed restriction have been reported: quantitative restriction, where the daily amount of feed provided is reduced, and qualitative restriction, with ad libitum access to feed for which the protein content is decreased to reduce the caloric intake without reducing feed volume (Aviagen Turkeys, 2025a, 2025b).

Feed management during rearing

During rearing, the protein content of the feed provided decreases as turkeys age (Aviagen Turkeys, 2015). Breeding companies recommend managing the body weight of turkeys through the protein content in the feed by applying qualitative feed restriction. This is done by transitioning heavier turkeys to the next dietary phase earlier than initially planned and maintaining lighter birds on high-protein rations (Aviagen Turkeys, 2025a; Hendrix genetics, 2023).

Feed management of toms

Toms are quantitatively feed restricted with a fixed daily quantity of feed (based on weekly body weight), with targeted weight gains of 100–200 g per day and avoiding strictly any weight loss that would compromise sexual maturation (Hendrix genetics, 2023).

Described in the Aviagen guidance (Aviagen Turkeys, 2025b), growth management is important for semen production, as toms that are too light may be stunted and slow to mature, while heavy toms may have posture and mobility problems, which will shorten their production life as breeders. Heavy toms may also be close to their maximum body weight, reducing the potential for continued weight gain later in life, which is a key factor for maintenance of fertility. These issues are managed by qualitative feed restriction.

The level of feed restriction practised in turkey toms during production is ranging from no restriction to restriction of feed intake down to 80%–90% of ad libitum consumption (Leveque, 2025 personal communication).

Feed management of hens

As for toms, weekly weighing is a critical management practice in hens, ensuring that dietary regulation remains responsive to the flock's actual growth trajectory (as compared to the target growth curve). For hens that exceed target weights, Aviagen Turkeys discourages the use of severe feed restriction and instead recommends establishing a parallel growth trajectory for overweight hens after 16 weeks of age, rather than attempting to force a return to target weights (Aviagen Turkeys, 2025a). In contrast, Hybrid Turkeys does not recommend a parallel growth approach, and advises earlier transitions to the next dietary phase (less concentrated in proteins) or modifications of feed composition when birds deviate from the target weight curve (Hendrix genetics, 2023). No data are available about specific situations in practice.

Scientific background on feed restriction programmes

Feed restriction programmes have been investigated in the late 1990s and early 2000s with a focus on reproduction and production performance and not on welfare indicators.

Mules and Leeson (1990) studied the impact of quantitative reduction of feed (e.g. 85%–95% of ad libitum consumption) or skipping feed 1 or 2 days a week on the productive and reproductive performances of turkey breeders. They concluded that quantitative daily restriction is more effective than time-based (skip-a-day) restriction in managing growth and carcass fat in turkey breeder hens.

Crouch et al. (1999) evaluated whether early (during rearing) quantitative feed restriction would improve subsequent reproductive performance in two genotypes by comparing ad-libitum fed controls with birds restricted fed either from 3 to 16 weeks or from 6 to 16 weeks of age. They suggested that production benefits are contingent on optimised nutrition and on meeting body weight and physiological thresholds before photostimulation (i.e. during rearing).

Revington and Moran (1990) evaluated the effects of qualitative feed restriction and feed form (pellets or mash) on growth, carcass composition and reproductive traits in heavy breeder turkey toms. Neither nutrient level nor feed form had a consistent effect on semen volume or sperm concentration. The authors concluded that while qualitative restriction

using low-nutrient-concentration feeds may temporarily alter body composition and delay fat accrual, it did not yield sustained reproductive benefits.

Crouch et al., 2002a, 2002b investigated how varying the timing and duration of quantitative feed restriction (skip-a-day) influenced growth performance indicators in Nicholas Large White turkey breeder hens. Crouch et al. (2002a) found that overall feed conversion (feed consumption per body weight gain from 3 to 54 weeks) was highest in the ad libitum and late restriction groups, with the full restriction group having the lowest feed conversion. At the end of lay, hens in the late restriction group did not differ in body weight from the ad libitum fed hens, and fully restricted hens were not different from early restricted hens (having a lower body weight). Crouch et al. (2002b) evaluated how these same feeding strategies affected reproductive output in turkey breeder hens. Hens that experienced early or early and prolonged restriction produced significantly more eggs during the first 5 weeks of lay compared to ad-libitum-fed and late-restricted hens. Fertility and total hatchability were not significantly affected; however, the hatch of fertile eggs was higher in the late-restricted hens compared to the early and prolonged restriction treatments, with the ad libitum treatment being intermediary. Poults produced per hen were higher in the ad libitum and late-restricted treatments. The authors suggested that early restriction may accelerate reproductive onset, but compromise long-term productivity.

3.2.13.2 | *Welfare consequences associated with feed restriction*

There are very few results on the impact of feed restriction on the welfare of turkeys. Results obtained for broiler chicken breeders has limited relevance for turkeys as the quantitative feed restriction applied in turkeys is less severe than the one applied in broiler breeders. Most available literature on the welfare impact of feed restriction in broiler chicken breeders focuses on the rearing period, where the feed is restricted down to 20%–25% of the ad libitum consumption (Riber, 2020), whereas no quantitative feed restriction is applied during rearing of turkeys or turkey hens during production, and the most severe level of feed restriction of turkey toms is reducing feed quantity down to 80%–90% of ad libitum consumption.

From literature on broiler chicken breeders, it is known that the more severe the quantitative feed restriction, the more severe the welfare consequences. Prolonged hunger and Group stress (EFSA AHAW Panel, 2023a), but whether this finding can be translated to turkeys is not known. In turkeys only one study was found looking at quantitative feed restriction. Hocking (1999) examined experimentally the impact of severe quantitative feed restriction in both Large-white turkey hens and toms (i.e. achieving a daily live weight gain during the rearing period of about 0.5 of when fed ad libitum, which is comparable to the practice in broiler breeders) vs. typical commercial-practised feeding of turkey breeders during the rearing period (i.e. no feed restriction). The restriction at photostimulation and during production was the same for both treatments (two-thirds of ad libitum food consumption at photostimulation and 0.8 thereafter). Traditional and Large-White turkeys fed ad libitum were used as controls. The welfare of male and female male-line (Large white) turkeys fed ad libitum or food-restricted was assessed at 4, 8, 12, 16, 20, 24, 28, 36/38 and 46/48 weeks of age using behavioural and physiological indicators of welfare. Quantitative feed restriction in male and female male-line turkeys (all treatments) was associated with an increase in oral activity (eating, drinking and object pecking), and the rate of birds pecking at the walls and furnishings of the pens was relatively high compared to ad libitum treatment.

The heterophil–lymphocyte ratio (HLR) is a well-established index of stress, and basophils increase in situations of extreme heat or transport stress (Hocking et al., 1993). Feed restriction was not associated with an increase in HLR in turkey toms and hens, and, in contrast to feed-restricted broiler chicken breeders, there was no increase in basophils in restricted turkeys (Hocking, 1999). According to the authors, the results can be explained by the fact that turkeys may be physiologically more resistant to feed restriction than broiler chicken breeders or by the fact that the restriction was not as severe as that of broiler chicken breeders. Importantly, the authors concluded that the practice of classical turkey breeder restriction of males from 18 weeks, which is commercially used to improve semen production, had no adverse medium- or long-term welfare consequences in this study (Hocking, 1999). However, in the opinion of EFSA experts, the transient increase of corticosterone and the increase in foraging and pecking behaviour (Hocking, 1999) can be seen as signs of stress and frustration, potentially due to Prolonged hunger caused by this level of feed restriction and potentially Group stress due to competition for access to resources.

Turkey breeders, when subjected to qualitative (i.e. protein reduction) feed restriction, may experience hunger; however, no scientific evidence is available to assess whether this leads to Prolonged hunger, as well as on the severity of this welfare consequence when feed restriction is applied in practice in turkey breeders.

It has been established for broiler chicken breeders that the bigger the space at feeder, the less the competition for feed and associated welfare consequences (EFSA AHAW Panel, 2023a) but no data are available for the specific case of the turkey breeders.

3.2.13.3 | *Preventive measures*

Prolonged hunger due to feed restriction is prevented by a feed ration that contains enough nutrients to cover the daily energy consumption of the bird (i.e. prevent metabolic hunger; (Savory et al., 1996) and a sufficient volume to satisfy the behavioural motivation of appetitive and consummatory foraging.

3.2.13.4 | *Mitigation measures*

For both hens and toms, provision of sufficient feeder space per individual may mitigate the risk of: (i) Group stress due to competition for resources and (ii) Prolonged hunger for some individuals due to limited access to feed in case of quantitative restriction.

A feeding regime, allowing a body weight gain that follows the target growth trajectory without deviations and without restricting the feed quantity to less than 80% of ad libitum, may mitigate the risk of Prolonged hunger, but no data are available for turkey breeders that demonstrate the absence of Prolonged hunger.

Monitoring the growth trajectory of the turkey hens minimises the risk that they deviate from the target weight. Quick reaction to a body weight exceeding the target and smooth adjustment in feeding (avoiding drastic drops in protein for birds less than 14 weeks of age, e.g. by switching to the next diet) helps preserve health and regular growth of birds and therefore may mitigate Prolonged hunger due to uncovered nutritional needs, but no data are available for turkey breeders that demonstrate absence of Prolonged hunger.

In case of large variation in body weight between individuals, dividing the tom flock into two or three weight groups and feeding each group accordingly may mitigate Prolonged hunger in smaller birds.

Mitigation measures to reduce Prolonged hunger applied in broiler breeders are spin (scatter on the litter) feeding and qualitative restriction (via addition of insoluble fibre to the feed) instead of quantitative restriction (EFSA AHAW Panel, 2023a). The spin feeding reduces competition over feed, allowing smaller individuals better access to feed. Although there is a gap in knowledge on mitigation measures in turkeys, the methods applied to broiler chicken breeders may also be used in turkeys, but it will require more research to be certain.

3.2.14 | Hatchery conditions

3.2.14.1 | *Background*

A description of the steps and procedures performed in hatcheries can be found in EFSA (2026). In brief, fertilised turkey eggs are incubated for 25 days before being transferred to the hatcher. Hatching starts on embryonic day 26, but the majority of the poults hatch on embryonic days 27–28 (Fairchild & Christensen, 2000; Rozenboim et al., 2003). This spread in hatch from first until last poult, termed the hatching window, lasts from minimum 8 to maximum 48 h. Incubation, hatching and drying take place in complete darkness in the incubator and hatcher. Once removed from the hatcher, the poults undergo a series of hatchery procedures collectively referred to by the industry as servicing. These processes are typically automated, with trays of poults transported through the hatchery using rollers and conveyor belts. The hatchery procedures include: (i) separating poults from eggshells and other debris, (ii) grading poults into first- and second-grade categories (the latter being culled), (iii) cloacal sexing, (iv) carrying out mutilations (see Section 3.2.12) and (v) administering vaccinations. First-grade poults are then counted and placed into sex-sorted transport boxes that are kept in a waiting room until they are transported to brooding facilities.

3.2.14.2 | *Hazards linked with hatchery conditions and associated welfare consequences*

Increasing evidence suggests that early-life experiences can have long-lasting effects on animal welfare, underscoring the significance of hatchery conditions (Schwean-Lardner, 2018). The identified welfare consequences associated with hatchery conditions are Umbilical disorders, Locomotory disorders (including lameness), Eye disorders, Sensory under- and/or overstimulation, Resting problems, Restriction of movement, Prolonged hunger, Prolonged thirst and Handling stress. The identified hazards for the welfare consequences occurring due to hatchery conditions relate to the period before incubation, the period during incubation and hatching and the period following removal of the poults from the hatcher. For the period before incubation, the identified hazard is 'excessive egg storage duration'. For the incubation and hatching period, the hazards identified are 'lack of a diurnal light/dark schedule' and 'excessive noise'. For the period after removal from the hatcher, the hazard is 'inappropriate handling and equipment', which involves changes in velocity, drop heights and speeds of the conveyor belt, drops to the floor and poorly designed systems. In addition, the period from hatching to initiation of transport is considered a hazard if too long, resulting in the hazard 'too long feed and water deprivation' (EFSA AHAW Panel, 2022a).

In the following paragraphs, these hazards will be discussed in relation to the associated welfare consequences. However, most hatchery-related research has focused on broiler or layer chicks, creating a notable knowledge gap regarding the welfare of turkey poults. Nevertheless, due to the similarities in hatchery conditions and between poults and chicks at this life stage, the EFSA experts consider it likely that the scientific knowledge relevant for the topic based on research in layer and broiler chicks also applies to turkey poults. No research has until now been conducted to confirm this.

3.2.14.2.1 | *Excessive egg storage duration*

The duration of storage of hatching eggs is a hazard as it may result in reduced embryo survival and poor poult quality. Mróz et al. (2019) examined the egg storage duration in B.U.T. 6 turkey eggs ($n = 1512$ per storage duration; 6048 eggs in

total). Eggs were stored for 7, 10, 13 or 17 days before incubation. Post-hatch, poults were assessed for physical defects. Longer storage increased the prevalence of abnormalities, particularly umbilical defects, and late-hatched poults unsuitable for rearing (not further specified). Although the frequencies were at a much lower scale, poor motor activity and eye abnormalities also increased with the duration of egg storage. Similar findings have been reported for chicks (e.g. (Tona, Bamelis, et al., 2003)), where an increase in hatching window has also been reported to result from increased egg storage duration (Tona, Bamelis, et al., 2003; Tona, Malheiros, et al., 2003).

Thus, based on the one study available on poults, but supported by similar findings from chicks (*Gallus gallus domesticus*), the hazard 'excessive egg storage duration' is associated with the welfare consequences Umbilical disorders, Locomotory disorders (including lameness) and Eye disorders.

Determining a maximum egg storage duration to prevent the associated welfare consequences is impeded by the limited research into this topic, but some insights may be gained from early research exploring the effects of egg storage duration on hatchability. Kosin (1954) studied eggs stored for 1–14 days and found that hatchability declined after 7 days, while no differences were observed between 1 and 7 days. Becker (1963) confirmed these findings, showing reduced hatchability between 8 and 14 days and again from 15 to 21 days compared with the 1–7 day period. More recently, Fassenko et al. (2001) compared storage durations of 4 and 14 days and reported higher embryo mortality on days 1–7, 26 and 27, along with lower hatchability in eggs stored for 14 days vs. 4 days. Based on these findings, the general recommendation is to avoid storing eggs for more than 7 days (Aviagen Turkeys, 2021). However, most studies report hatchability rates without distinguishing between infertile eggs and embryonic death, nor do they clarify whether embryo loss occurred during the period of sentience. Consequently, hatchability serves better as an indicator of productivity than of animal welfare, since reduced hatchability can result from factors unrelated to welfare. Still, until more relevant knowledge from research focusing on welfare is gained, hatchability may provide some indications of a maximum egg storage duration, potentially preventing some welfare consequences.

3.2.14.2.2 | Lack of a diurnal light/dark cycle

During incubation and hatching, light is generally not provided, meaning turkey embryos and poults are kept in complete darkness. After hatching, poults may remain in the hatcher for up to 48 h, depending on the hatching window. Once removed from the hatcher, the poults are exposed to light, which is typically supplied continuously or near-continuously during the first days. Exceptions include time spent in the waiting room, where low-intensity blue light is often used, and during transport.

Poultry embryos develop the ability to see, hear and smell at various stages during incubation, and can perceive environmental stimuli even before hatching (Fairchild & Christensen, 2000; Reed & Clark, 2011). Research in chickens suggests that lack of light during incubation may reduce stress resilience (Zeman et al., 2004), increase general fearfulness (Archer & Mench, 2017) and suppress social exploration (Dayioglu & Özkan, 2012). Only the presence at chosen time points (ranging from embryonic day 19 to 6 weeks of age), and not the duration, of these effects was examined in these studies, except from the study by Archer and Mench (2017) where effects were found throughout the life of the broilers (slaughtered at 42 days of age). In layer chicks, omitting light during the hatching period has been found to impair their ability to discriminate and learn spatially in feed-related tasks (Rogers, 2008; Rogers et al., 2007).

Thus, in chicks (*Gallus gallus domesticus*), the hazard 'lack of a diurnal light/dark cycle' influences welfare indicators that have been linked to the welfare consequences Sensory under- and/or overstimulation and Resting problems. No studies have been found examining the welfare benefits of introducing light/dark cycles during the incubation or hatching phases in turkeys. However, EFSA experts consider that existing knowledge from chicks (*Gallus gallus domesticus*) is equally applicable to turkeys.

3.2.14.2.3 | Excessive noise

The systems supplying heat and ventilation in incubators generate a continuous background noise, which has been measured at approximately 70 dB (Tong et al., 2015) and reported to be up to 90 dB (Van Poucke et al., 2023), though this varies depending on the specific system.

In chickens, sounds during incubation can affect social behaviour, fear responses, cognition and stress reactivity (Crouch et al. (2002a, 2002b)). Only the presence at chosen time points (ranging from embryonic day 12 to 5 days of age), and not the duration, of these effects was examined in these studies. Kesar (2014) reported that chicks exposed to 110 dB noise (unpatterned, 15 min/h over the period of 24 h) from embryonic day 10 until the day of hatching exhibited decreased body weight, brain weight and brain size on the day of hatching. The documented effects of the hazard 'excessive noise' during incubation seem primarily to be investigated on a short-term scale (e.g. 110 dB, 1 day post-hatch: Sanyal et al., 2013), whereas effects of 'excessive noise' exposure in the early post-hatch period on later welfare are unknown. The threshold level of when noise induces the welfare consequence Sensory overstimulation and becomes a welfare concern is unknown due to a lack of research, but evidence of negative effects has been found in chicks (*Gallus gallus domesticus*) from 90 dB (no further details provided on the sound characteristics, (Rodenburg et al., 2017)). The severity of Sensory overstimulation may also depend on other factors such as embryonic age, duration and nature of the noise.

Thus, in chicks (*Gallus gallus domesticus*), 'excessive noise' during incubation is associated with the welfare consequence Sensory overstimulation, at least in the short-term, whereas a gap of knowledge exists when it comes to the long-term

effects. No studies have been found examining the welfare consequences of the hazard 'excessive noise' during the incubation or hatching phases in turkeys. However, EFSA experts consider that existing knowledge from chicks (*Gallus gallus domesticus*) is equally applicable to turkeys.

3.2.14.2.4 | *Too long feed and water deprivation*

The hatching window (8–48 h) is followed by a drying period in the hatcher lasting 6–10 h, where the humidity is decreased and the ventilation increased (EFSA, 2026). Then the poults are pulled from the hatcher and go through the hatchery procedures, which may last between 2 and 3 h (EFSA, 2026). When placed in transport boxes, the poults are kept in a waiting room for some time (max duration unknown) before being transported. Adding to this comes the duration of the transport to the brooding facilities. Thus, the poults, especially the early-hatched ones, may experience a considerably long period between hatch and being placed on farm, where they can access feed and water.

Newly-hatched poults possess a yolk sac that supplies nutrients essential for maintenance and growth during the immediate post-hatch period (Moran Jr & Reinhart, 1980). The extent to which the yolk sac is utilised depends on whether the poult has access to feed and water during the holding period (EFSA, 2026). Moran Jr and Reinhart (1980) observed that, when assessed 2 days after hatching, feed and water deprivation resulted in reduced yolk absorption compared to poults that were fully nourished. Romanoff (1944) reported a similar effect after 3 days of fasting experimental poults.

Pinchasov and Noy (1993) found that 48 h of feed and water deprivation negatively affected organ development and led to loss of approximately 10% of the poults' initial post-hatch body weight. This weight loss was more pronounced in poults exposed to Heat stress (35–38°C) during the same period. The authors concluded that poults deprived of feed and water for 48 h post-hatch experience a severe energy deficit, resulting in altered body composition, impaired early growth and increased mortality under Heat stress conditions.

Mayes and Auckland (1976), cited in: Moran Jr & Reinhart, 1980) reported increased starve-out mortality (i.e. poults found dead with no feed in the digestive tract) when placement was delayed by more than 10 h (no further details provided). Moran Jr. (1990) investigated the interaction between egg weight (low, medium, high) and fasting (fed vs. fasted for 3 days). Poult mortality within the first 14 days was found to be 7.4% if the poults were fasted and stemming from eggs of low weight, while the mortality of fed poults was 2.1%. Poults from egg of medium weights also benefited from immediate access to feed and water after hatch compared to being fasted (Mortality: 5.1% vs. 4.2%), whereas poults from eggs of heavy weight had a lower mortality when fasted compared to being fed (2.7% vs. 4.8%). Roehrig and Torrey (2019) could not confirm, under experimental conditions, that delayed access to feed and water was the major cause for early poult mortality. Instead, the authors found that poults being at least 24 h old at the time of pulling from the hatcher were more likely to die from bacterial infections of the yolk sac (caused mainly by yolk sacculitis) and less likely to die due to starvation than poults in a group representing a random selection of ages within the hatching window (early vs. standard hatched; yolk sac infection: 3.61 ± 0.72 vs. $1.56 \pm 0.77\%$; starve-out: 0.63 ± 0.33 vs. $1.81 \pm 0.35\%$). The authors suggested that the early-hatched poults may be more prone to bacterial infections due to their extended exposure to pathogens in the hatcher and increased risk of becoming dehydrated. However, Roehrig and Torrey (2019) also stressed that the prevalence of more than 1% of the placed poults dying from starvation is a major welfare concern (overall early age mortality rate: 4.1%).

The available knowledge on how the holding period affects turkey poult welfare is based largely on older studies. Nevertheless, these findings are consistent with more recent research on broiler chicks, which shows that negative long-term effects on mortality and performance begin after an average of 48 h (range: 36–60 h) of feed and water deprivation (de Jong et al., 2017; Willemsen et al., 2010). In broilers, short-term impacts on organ development and reduction of plasma T3 (indicating a lower metabolic rate) and glucose concentrations (indicating a physiological need for energy) have also been observed (de Jong et al., 2017). Moreover, an excessive time without water access may lead to lethargy and prostration in chicks (Borges et al., 2004), a condition that may be worsened by excessively high effective temperatures during the holding period in transport boxes (Maman et al., 2019; Xin & Harmon, 1996). In a previous EFSA SO (EFSA AHAW Panel, 2023a), it was concluded that day-old chicks subject to feed and water withdrawal periods longer than 48 h will be at risk of experiencing Prolonged hunger and Prolonged thirst (with 90%–100% certainty). In the opinion of the EFSA experts, the same consideration could be applied to day-old poults.

In summary, if the feed and water deprivation is longer than 48 h, the yolk sac alone cannot meet the full nutritional needs of the newly-hatched poult and cannot compensate for the absence of feed and water without adverse long-term effects on welfare. Consequently, all turkey poults experience some degree of hunger and thirst, and a proportion will experience the welfare consequences Prolonged hunger and Prolonged thirst due to feed and water deprivation lasting longer than 48 h from the time of hatching, resulting in a negative impact on their survival and development.

3.2.14.2.5 | *Inappropriate handling and equipment*

The hatchery procedures require the poults balancing on conveyor belts, being dropped from one belt to another or into transport boxes, being sorted by grade and sex, having vaccinations via spray or injection and being subjected to different types of mutilations. Hatchery procedures involve both mechanical and manual handling, which may be perceived by the poults as rough depending on factors such as belt speed, drop height, system design, as well as staff training and behaviour. For instance, the typical drop height between belts or from belt to transport box is around 10–15 cm, but in some hatcheries, the drop from belt to transport box can reach 25–35 cm (EFSA, 2026).

Donaldson et al. (1991) examined poults at four different stages within 1 h of being removed from the hatcher: before any handling, after sexing, following desnooding and toe trimming, and after beak trimming and antibiotic injection. Blood was sampled at all stages 75 min after removal from the hatcher, i.e. all poults (regardless of stage of the hatchery procedures) were exposed to the same duration of feed deprivation following removal from the hatcher. Their findings showed that the first procedure, cloacal sexing, was enough to raise blood glucose levels. However, a reduction in hepatic glycogen only occurred after all procedures had been completed. As glycogen, stored primarily in the liver and muscles, is used as a source of energy, this indicates that the hatchery procedures contribute to exhausting the poults.

Consistent with this, several studies have demonstrated that standard hatchery procedures are stressful for layer chicks, leading to both immediate and long-term effects on their behaviour and stress reactivity (e.g. Hedlund et al., 2019; Van Poucke et al., 2023). Layer chicks undergo hatchery procedures that are nearly identical to those applied to turkey poults, except for desnooding and toe trimming, which are not performed on layer chicks. Knowles et al. (2004) proposed that handling stress in hatcheries may also stem from incidents such as drops to the floor and poorly designed systems, where birds can become trapped, caught, smothered or crushed.

Thus, the hatchery procedures that newly-hatched poults and chicks undergo are perceived as stressful, with the hazard 'inappropriate handling and equipment' resulting in the welfare consequence Handling stress. In addition, the poults are densely packed in transport boxes as the last step in the hatchery procedures. The limited space allowance in these boxes leads to Restriction of movement and likely increases the frequency of bird-to-bird disturbances, causing Group stress. Combined with the other hatchery procedures, this leaves little opportunity for the poults to rest, potentially posing a risk for the welfare consequence Resting problems. However, no research has been identified on this specific topic.

3.2.14.3 | Preventive measures

The welfare consequences Sensory under- and/or overstimulation and Resting problems due to the hazard 'lack of a diurnal light/dark cycle' can be prevented during both incubation and the period in the hatcher by introducing a diurnal light/dark schedule of approximately 12 h/12 h (Archer & Mench, 2017; Chiandetti et al., 2005). Likewise, the hazard 'excessive noise' can be prevented during incubation, hatching and during the hatchery procedures by avoiding loud fans in the incubators/hatchers and noisy mechanical systems (e.g. belts, automated beak/toe trimming) above 90 dB.

The welfare consequence Handling stress can be partly prevented by avoiding poor design of system components where poults can become caught, trapped, smothered and crushed (EFSA AHAW Panel, 2022a).

The welfare consequences Prolonged hunger and Prolonged thirst can be prevented by offering water and feed or liquid feed (such as hydrogels) combined with light in the hatcher and transport boxes before reaching 48 h after the first hatch. If feed and water deprivation is expected to last longer than 48 h from the first poult to hatch until all poults are placed in the transport boxes, then access to feed and water in the transport boxes is considered a mitigation strategy. Studies have shown that providing poults with immediate access to feed and water or liquid feed post-hatch increases their body weight (Hajati et al., 2024; Malheiros et al., 2013; Noy & Sklan, 1999) and reduces early life mortality rates (days 1–35; Hajati et al., 2024) as compared to being feed and water deprived for the first 48 h after hatch. Liquid feed in the hatcher or transport boxes constitutes a limited resource, for which the minimum amount needed per poult per hour of deprivation (from hatch of first poult to placement in the barn) to prevent Prolonged hunger and Prolonged thirst is currently unknown. It has been proposed that providing early access to feed and water may promote the development of the gastrointestinal system in broiler chickens (Willemsen et al., 2010). Research is needed on this topic for turkeys.

Although no studies have examined the effect of on-farm hatching in turkeys (i.e. placing the fertilised and incubated eggs for hatching in the barn instead of in the hatcher at the hatcheries), it can be expected to prevent Prolonged hunger, Prolonged thirst, Handling stress and Resting problems, as feed and water is immediately available for the newly-hatched poults, and the poults are not subjected to the hatchery procedures and transport. These benefits have been documented for broiler chicks (see (EFSA AHAW Panel, 2023a) for a review). However, in turkeys, due to the industry-need to administer early-life vaccinations, separate housing of the sexes (which necessitates sexing before placement in the barns) and the current practice of mutilations (see Section 3.2.11), on-farm hatching is only a viable practice if combined with in-ovo sexing, in-ovo vaccination and absence of mutilations.

The welfare consequences Umbilical disorders, Eye disorders and Locomotory disorders (including lameness) can be prevented by keeping the egg storage duration at a minimum.

3.2.14.4 | Mitigation measures

The welfare consequence Sensory overstimulation can be mitigated if loud noises occurring suddenly, e.g. due to equipment failure, are stopped immediately.

Providing feed and water combined with light is a mitigation measure if it is implemented after 48 h after the first poult hatched. Additionally, shortening the hatching window, minimising the number of hatchery procedures done, reducing waiting time before transport and shortening journey duration (see EFSA AHAW Panel, 2022a for details on transport) can help ensure earlier access to feed and water on the farm. Increasing the space allowance in transport boxes, enhancing ventilation and lowering the environmental temperature to match the poults' thermal comfort zone can help prevent dehydration of the poults and thus serve to further mitigate the welfare consequence Prolonged thirst.

The welfare consequence Handling stress can be mitigated through several measures, including reducing conveyor belt speed and drop heights, avoiding sudden changes in belt speed (e.g. when moving from belt to belt), ensuring considerate handling of poults, training staff in proper handling and supervision, and maintaining well-designed belts with regular upkeep and continuous monitoring (Knowles et al., 2004). Research on chicks (*Gallus gallus domesticus*) has shown that handling stress is minimised when conveyor belt speed changes are kept below 0.4 m/s, drop heights are under 280 mm, and belt speeds are less than 27 m/min (Giersberg et al., 2021; Knowles et al., 2004). Additionally, if a poult falls off the belt or is accidentally dropped to the floor, it should be carefully lifted using both hands to support its body, thereby reducing the risk of further stress due to improper handling.

The welfare consequence Resting problems can be mitigated by dimming the light intensity during the holding period, as it will encourage synchronous resting.

3.2.15 | Welfare aspects of genetic selection and breeding strategies

3.2.15.1 | Background

A description of the different categories of turkey breeders, the production cycle and housing systems of turkey breeders is provided in (EFSA, 2026). In turkey breeding, there are two major breeding companies (Aviagen Turkeys and Hybrid Turkeys), which hold approximately 50% of the global market share each. Details on which traits are included and how they are used in breeding programmes (e.g. trait definitions, measurement methods, relative weighing), or the phenotypic trends following selection (e.g. change in prevalence of a certain condition), are typically not disclosed by breeding companies (EFSA AHAW Panel, 2010). However, Neeteson et al. (2023) described the recent progress made in turkey breeding (Aviagen™ Turkeys), while van Staaveren et al. (2022) summarised efforts of a research project to apply genomic selection in turkeys for health, welfare, efficiency and production traits (Hybrid Turkeys).

The structure of the breeding industry of turkeys is similar to other meat birds, such as broiler chickens (EFSA AHAW Panel, 2010; Neeteson et al., 2023). In brief, the breeding pyramid includes selection of pure lines (pedigree) and further multiplication (great-grandparents) and cross-breeding (grandparents, parents) to produce turkey hybrids kept for meat production. Ultimately, this manner of breeding birds provides the benefits of heterosis, or the increase in desired traits in hybrid offspring compared to the purebred birds in previous generations (Falconer & MacKay, 1996). The process of breeding from pedigree to turkeys kept for meat production spans approximately 4 years (EFSA AHAW Panel, 2010; Neeteson et al., 2023). Hocking (2014) additionally cautioned that it takes considerable time for improvements in different traits, including those relevant to welfare, in breeding flocks to translate to commercial flocks.

Historically, breeding goals considered a single or a relatively low number of traits with a focus on production and reproduction, as these are economically valuable traits in turkey breeding. This involved production traits such as increasing body weight, breast meat weight/yield and average daily gain, as well as reproduction traits such as egg production, fertility and hatchability (Clark et al., 2019; Havenstein et al., 2007) (Table 13). There was less focus on welfare traits. As such, genetic selection for production and egg production traits is considered a reason for increased welfare issues, particularly musculoskeletal disorders (reviewed by Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)) further detailed throughout this section. However, the conditions have a multifactorial aetiology which also includes several management factors as hazards and thus cannot be solely attributed to genetics (Dibner et al., 2007). From a breeder industry's perspective, to optimise genetic progress, the selection index used combines the heritabilities, genetic correlations and economic values of each considered trait (Hocking, 2014).

Due to the increase in welfare issues, breeding goals have expanded to also include traits related to animal health and welfare, such as leg health, since the 1970s (Neeteson-van Nieuwenhoven et al., 2013). Modern breeding goals are now used to select desirable production, health, welfare and reproduction traits simultaneously (Table 13), depending on specific objectives of each line (EFSA AHAW Panel, 2010). The focus in male lines of turkeys is typically on selection for high weight gain, high carcass yield and walking ability, while in female lines typically more emphasis is placed on reproductive efficiency (Flock et al., 2005). The breeding goals are not static and may be adapted depending on changing market and societal demands (Neeteson et al., 2023). Additionally, advances such as technologies to measure phenotypic traits, the assembly of the turkey genome, and improved computing power and statistical modelling (Abdalla et al., 2019; Aslam et al., 2012; Barros et al., 2023; Dalloul et al., 2010; Emamgholi Begli et al., 2021; Hocking, 2014; Neeteson et al., 2023) may also influence the inclusion and weighing of traits in a breeding goal or the accuracy of selection. The European Forum of Farm Animal Breeders have stated that currently 'more than 30% of traits focus on animal welfare' (EFSA, online). However, it is unclear whether this concerns turkeys or poultry in general, if this includes both health and welfare-related traits, which traits on welfare are specifically included or how much emphasis is placed on each specific welfare trait.

TABLE 13 Traits that are reported to be considered in current turkey selection programmes (adapted from information provided by EFFAB stakeholder meeting 2023 and code for poultry (EFSA, [online](#); EFSA AHAW Panel, 2010; Jong & Swalander, 2012). The actual (combination of) traits considered in a breeding programme depends on the objective of a specific genetic line and market or societal demands.

Areas for selection ^a	Major trait categories ^b
Health and welfare	Liveability, disease resistance, leg health (footpad lesions, hockburn issues, angular deformities) and gait/walking ability, cardiovascular capacity and function, cannibalism, feather pecking, behaviour, gut health and bird physiology, genetic defects
Reproduction	Egg production, fertility, hatchability, egg quality
Production	Body weight, carcass yields incl. breast meat yield, feed conversion ratio, residual feed intake, average daily gain, carcass and meat quality

^aAreas for selection as provided by EFFAB and breeding industry.

^bTrait categories may include multiple traits.

3.2.15.2 | *Hazards linked with genetic selection and breeding strategies in turkeys and associated welfare consequences*

Genetic selection requires accurate phenotypes for heritable traits of a large number of individuals, which preferably can be measured at low cost and in a non-invasive manner (Brito et al., 2020). Generally, turkey breeders need to be handled for different reasons, including artificial insemination (see Section 3.2.12), but also when measuring certain traits for phenotyping, or collecting blood samples for e.g. genotyping, health reasons or export regulations. ‘Inappropriate handling’ is a hazard in these steps and is associated with the welfare consequence Handling stress. Breeding companies have indicated that they aim to minimise handling as much as possible, for example, by measuring multiple traits at the same time (Burnside & Ralph, 2024 personal communication), but there is no scientific information available to confirm the welfare implications of this.

While this section focuses on genetic selection, it should be noted that the welfare consequences described throughout the text are not solely due to genetics. Other factors (e.g. housing, environment and management) also play a role in their development. These factors are addressed elsewhere in this SO.

Genetic selection and breeding strategies can influence the health and welfare of turkeys in two ways:

- Indirectly through (un)favourable genetic relationships with other traits (e.g. production or reproduction traits) that are being selected for or against.
- Directly through targeted selection for or against specific health- or welfare-related traits (e.g. liveability/disease resistance, leg health/walking ability, behaviour).

This section will first describe the selection for production and reproduction. Selection for these traits is considered a reason for increased welfare issues, particularly musculoskeletal disorders (reviewed by Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). To avoid repetition, the unfavourable relationship between production and welfare is discussed in paragraphs detailing the selection of the different health- or welfare-related traits under the overarching themes of liveability/disease resistance, leg health/walking ability and behaviour. Thus, specific examples of (un)favourable correlations between production and reproduction traits are only described in Section 3.2.15.2.1, while (un)favourable correlations between (re)production traits and other traits important to the welfare of turkeys are detailed in their respective sections (Sections 3.2.15.2.1–3.2.15.2.4). The final section explains briefly how breeding companies deal with these unfavourable relationships between traits (Section 3.2.15.2.5).

3.2.15.2.1 | *Production and reproduction*

The selection for production and reproduction encompasses economically valuable traits in turkey breeding.

For meat production, the progress made in this area is highlighted by Havenstein et al. (2007), who compared the performance of a randombred control turkey line from 1966 to modern commercial turkeys (Nicholas, B.U.T., Hybrid) hatched in 2003. The modern turkeys were twice as heavy (body weight increasing by approx. 208 g/year in toms and 140 g/year in hens during the 37-year time span), and the number of days needed to reach slaughter weight was halved, while no difference in mortality was observed compared to the randombred control line (Havenstein et al., 2007). In a more recent update, covering 50 generations, Clark et al. (2019) showed that a line selected for increased body weight at 16 weeks was 7.9% heavier at hatch, 2.5 times heavier at 16 weeks (16.4 ± 0.4 kg vs. 6.7 ± 0.4 kg) and had a 2.5 times greater average daily gain (146.5 ± 3.39 g) compared to the randombred turkeys (59.9 ± 3.39 g). Similarly, higher carcass weights, *pectoralis major* and *pectoralis minor* weights were reported, with the *pectoralis major* representing 19.3 ± 0.4% of body weight in the line selected for increased body weight compared to 18.0 ± 0.4% in the randombred line (Clark et al., 2019).

Selection for production traits in turkeys has focused on increasing body weight and breast meat weight/yield. Breast meat weight (kg) and/or breast meat yield (expressed proportionally to body weight) are highly heritable (e.g. Aslam et al., 2011; Havenstein et al., 1988 ; Vanderhout, Leishman, Abdalla, et al., 2022). The weight or yield of other carcass cuts is also heritable and often correlated to breast meat (Dewez et al., 2018; Neeteson et al., 2023). It has been suggested to

consider these genetic correlations between carcass cuts, as stronger emphasis on breast meat traits in selection may still lead to disproportionate development of leg muscles (Havenstein et al., 1988; Vanderhout, Leishman, Abdalla, et al., 2022) (Section 3.2.15.2.3). It should be noted that breast meat weight or breast meat yield are traits that can only be collected post-mortem, or indirectly through conformation scores (Case et al., 2012). New technologies such as computed tomography (CT) can provide information on the in vivo body composition of turkeys and may allow more accurate measurements on the live animal instead of proxies (Dewez et al., 2018; Neeteson et al., 2023).

Several studies have indicated that there is no evidence yet for a plateau in selection response for body weight or egg production in turkeys (Clark et al., 2019; Nestor et al., 1996; Nestor et al., 2000). However, selection for some of these traits can have negative effects. A well-known example is the unfavourable genetic correlation between body weight and egg production (Nestor et al., 1996; Nestor et al., 2000). As such, genetic lines are often specialised in either meat production traits (male lines) or reproduction traits (female lines).

Emamgholi Begli et al. (2019) reported estimated heritabilities for conventional egg production traits such as age at first egg (0.22 ± 0.03), egg number (0.28 ± 0.03) and rate of lay (0.29 ± 0.03), as well as clutch traits such as clutch length (0.21 ± 0.03), pause length (0.25 ± 0.03) and (indirectly) broodiness (0.15 ± 0.03), as indicated by the average number of consecutive pause days between clutches that was higher than the average pause length per hen. Unfavourable genetic correlations confirmed that turkeys with higher body weights had poorer egg production, with fewer eggs produced, smaller clutches and longer pauses between clutches. The authors suggested that selection against broodiness could be indirectly incorporated into selection programmes due to its correlation with clutch traits, as broodiness poses a problem to producers (Emamgholi Begli et al., 2019). However, the EFSA experts believe that broodiness is not a welfare issue per se (Section 3.2.8).

In terms of growth rate, the focus in turkeys is on the target weight (e.g. light/medium/heavy genotypes). To the best of our knowledge, there is no consensus on the definition of slower-growing turkeys in terms of average daily gain, or how this would map onto the definitions of light/medium/heavy genotypes. Only a limited number of studies compared the welfare of slow- and fast-growing turkeys (Durosaro et al., 2022; Olschewsky et al., 2021).

Olschewsky et al. (2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Deutscher Tierschutzbund e.V.) compared the Kelly Broad Breast Bronze, Hockenhull Large Bronze and Hockenhull Black genotypes under commercial organic conditions. In this context, the authors considered all three genotypes to be slower growing compared to modern genotypes (e.g. B.U.T. 6) and used the Kelly Broad Breast Bronze as a reference against which to compare the two genotypes with further decreased growth rates, namely Hockenhull Large Bronze and Hockenhull Black. In their experiment, the average daily gain from 1 day until 25 weeks of age was higher in Kelly Broad Breast Bronze (111 g) compared to Hockenhull Black (84 g; estimate -26.4 ± 6.7 g) but not different from the Hockenhull Large Bronze (101 g; estimate -9.9 ± 6.7 g). Similarly, the average breast weight at slaughter was higher in Kelly Broad Breast Bronze (5.9 kg) compared to Hockenhull Black (4.7 kg; estimate -1.0 ± 0.3 kg) but not different from the Hockenhull Large Bronze (5.7 kg; estimate -0.4 ± 0.3 kg). The slower growing Hockenhull Black had fewer cases with malposition of the legs (mean: 5.3%, 95% CI: 3.1%–9.0%), reduced injury rates (mean: 22.2%, 95% CI: 11.4%–38.7%) and less breast buttons (mean: 1.1%, 95% CI: 0.3%–3.4%), but more footpad dermatitis (mean: 64.6%, 95% CI: 33.4%–87.0%) than Kelly Broad Breast Bronze (malposition of the legs mean: 5.3%, 95% CI: 3.1%–9.0%; skin injuries mean: 30.2%, 95% CI: 16.4%–48.8%; breast buttons mean: 9.8%, 95% CI: 6.2%–15.1%; footpad dermatitis mean: 24.3%, 95% CI: 8.0%–54.1%). The Hockenhull Large Bronze had slightly more birds with problems concerning walking ability and plumage damage, but fewer birds with breast buttons, compared to the Kelly Broad Breast Bronze turkeys. There were no differences between genotypes in mortality, prevalence of breast blisters and use of the functional areas (feeding area, perches, winter garden or free-range area). All in all, the authors concluded that the effect sizes of differences between welfare indicators for the different genotypes were negligible to small, and that none of the genotypes had clear benefits or disadvantages in terms of welfare in the studied context. Unfortunately, this study did not include a comparison to one of the faster-growing genotypes (e.g. Hybrid Converter, B.U.T. 6), which could have perhaps answered questions on whether faster- and slower-growing genotypes differ in their welfare.

Durosaro et al. (2022) reported higher fear responses in Hybrid Converter turkeys compared to the slower-growing Nigerian indigenous turkeys. It is difficult to disentangle whether this difference is due to the difference in growth rates or other underlying differences between these genotypes. Erasmus (2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)) reviewed results from older selection experiments, which also indicated that selection for larger body weight may be associated with greater fearfulness. However, the different tests used to indicate fear in these studies (e.g. tonic immobility, T-maze, open field tests) are measured through locomotor responses. Erasmus (2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)) cautioned that results may also be due to difficulty in moving in larger birds. The general consensus is that differences in fear responses exist between genotypes, but it is difficult to determine whether this is attributed to increased growth rates or weights or other underlying biological and physiological differences between genotypes (Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)).

Lastly, one aspect which is receiving increased attention is the occurrence of muscle myopathies in turkeys. In broiler chickens, this development is linked to the rate of increase in the weight of the *pectoralis major* in such a way that the supporting respiratory and circulatory systems cannot keep up (Clark et al., 2019). Clark et al. (2019) suggested that similar issues could occur in turkeys as they found less endomysial and perimysial space in a line selected for increased body weight compared to the randombred control line. A recent review described similar muscle myopathies in turkeys, such as deep

pectoral myopathy, pale, soft, exudative (PSE)-like condition, dark-firm-dry (DFD) condition, white stripping, spaghetti meat-like and wooden breast (Zampiga et al., 2020), though little is known about the actual prevalence of these conditions or their potential welfare implications in turkeys. Vanderhout, Leishman, Abdalla, et al. (2022); Vanderhout, Leishman, Hiscock, et al. (2022) reported a prevalence of 88% for white striping (score > 0) in a turkey population, an estimated heritability of 0.15 and a moderate unfavourable genetic correlation between white striping and body weight and breast meat weight. Further investigation revealed pathways related to growth, muscle development, collagen formation, circulatory system development, cell response to stimuli and cytokine production that imply a link between hypoxia and oxidative stress and white striping (Vanderhout et al., 2024). The occurrence of muscle myopathies requires further investigation to determine their welfare implications, but this may underlie that selection for increased weight is a hazard for myopathies.

3.2.15.2.2 | *Liveability and disease resistance*

Liveability (also referred to as viability or survival) in turkeys can be selected for directly, using records of mortality and indirectly through correlated traits such as leg health, cardiovascular function or social behaviour (Neeteson et al., 2023; Quinton et al., 2011; Swalander, 2012). Examples of successful selection for liveability, general disease or stress resistance in turkeys are sparse in the literature (Flock et al., 2005). Quinton et al. (2011) reported an estimated heritability between 0.02 and 0.05 for early survival (up to 3 weeks of age), 0.12 for late survival (3–23 weeks of age) and 0.14 for longevity (number of weeks from hatch to death or removal), which are generally considered low. The use of selection on correlated traits may then improve selection accuracy and the genetic progress (Swalander, 2012). In Quinton et al. (2011), unfavourable genetic correlations between body weight and late survival and longevity were found. The authors subsequently highlighted the importance of including the latter two traits in the selection index to avoid potential decreased survival in response to selection for higher body weights. Alternatively, correlated traits such as walking ability could be included instead, as it was favourably correlated with late survival and longevity and had a higher heritability in comparison to the traits addressing survival (Quinton et al., 2011).

Genetic selection for increased body weight, and to a lesser extent egg production, has been associated with decreased immunological responses and increased disease susceptibility in turkeys (e.g. Bayyari et al., 1997; Huff et al., 2005; Nestor et al., 1996). Additionally, it has been suggested that the genetic selection for increased productivity (e.g. body weight, growth rates, breast muscle) may have contributed to more stress on the cardiovascular and respiratory systems (Respiratory disorders) (Richardson et al., 2025). The reason for this is that selection for productivity in turkeys has led to proportionally reduced body cavity space and organs that are too small to fully support the animal (Havenstein et al., 2007). CT scans allow breeding companies to investigate the *in vivo* body composition of turkeys over time (Dewez et al., 2018). This methodology can aid in selection for meat yield traits, but is currently also being investigated as a way to improve liveability. Areas that are being explored include identifying birds susceptible to circulatory disorders (such as ascites, aortic rupture and spontaneous cardiomyopathy), as well as measuring the size and shape of organs (such as lungs and heart), to provide information on blood flow and ability to support increased yields (Musselman, 2024). Initial investigations reported a moderate heritability for lung traits, but cautioned that further research is needed as low genetic correlations with high standard errors were observed between breast meat traits and lung traits (Richardson et al., 2024).

Moderate heritability (range: 0.12–0.17) has been reported for pendulous crop (Gastroenteric disorders) (Abdalla et al., 2021; Quinton et al., 2011; Willems et al., 2014), suggesting that reducing the susceptibility to pendulous crop could be possible through selection. However, correlations with other traits should be considered to make a decision on including this trait in a selection index. Both Abdalla et al. (2021) and Willems et al. (2014) reported low but unfavourable genetic correlations with body weight, breast meat yield and feed efficiency traits. Investigating the correlations between pendulous crop and reproductive traits was also recommended for better understanding (Willems et al., 2014), however, to the best of our knowledge, no reports on this have been published.

In summary, overall health and liveability may be affected by genetic selection, either by direct or indirect selection. Direct selection for health and liveability is limited due to difficulties in phenotyping traits and low heritabilities of traits (though advances have been made in selecting traits with low heritabilities) and. Correlated traits can be used instead, but care should be taken to understand the biological relationships between traits.

3.2.15.2.3 | *Leg health and walking ability/gait*

The selection for increased body weight, particularly with a high breast meat yield, is associated with impaired walking ability (e.g. Kapell et al., 2017; Mulim et al., 2024; Quinton et al., 2011). Through structural equation models, Abdalla et al. (2021) showed that a 1-unit genetic improvement in body weight was expected to result in a 0.27-unit decrease in walking ability. Differences in gait and/or bone characteristics have been observed between wild and domesticated turkeys (Stover et al., 2018), across genetic lines (Oviedo-Rondón et al., 2017), and between birds with different leg disorders (Oviedo-Rondón et al., 2018). Leg health traits (Locomotorory disorders including lameness, Restriction of movement) were included in breeding programmes of turkeys in the 1970s (Kapell et al., 2017). Major breeding companies now use a combination of (sub)clinical assessment of leg defects (Neeteson et al., 2023) and an assessment of walking ability or gait score as an overall measure of leg health (Kapell et al., 2017; Quinton et al., 2011). Walking ability is a subjective assessment of individual birds wherein a range of attributes is considered, including aspects such as motion, posture, leg angulation and leg structure. Heritability of walking ability ranges between 0.08 and 0.26 (Abdalla et al., 2019; Kapell et al., 2017; Mulim et al., 2024;

Quinton et al., 2011; Soyalp et al., 2023). Leg defects are assessed through physical examination based on their presence or absence (clinical), but also increasingly with the help of technologies to assess subclinical alterations in live birds (e.g. lixiscope X-ray imaging for tibial dyschondroplasia, CT scanning of skeletal integrity) (Neeteson et al., 2023). Heritability of leg structure (poor hocks or angulation, short legs) has been reported as low (0.08), which the authors attributed to the composite nature of this trait (Quinton et al., 2011). Kapell et al. (2017) estimated heritabilities of 0.01 to 0.07 for varus and valgus deformities and 0.06 to 0.12 for tibial dyschondroplasia as specific defects of interest in turkey breeding, values which are considered low. However, walking ability or gait score had moderate to highly favourable genetic correlations with leg structure (Quinton et al., 2011), leg defects (Mulim et al., 2024) and valgus-varus deformities (Kapell et al., 2017), suggesting that selection for improved walking ability is expected to improve leg structure and reduce incidences of leg defects. Additionally, turkeys that show signs of leg disorders and families that are prone to develop leg disorders are excluded from reproduction (Flock et al., 2005; Kapell, 2019).

Another important trait that is considered in breeding programmes is FPD (Soft tissue lesions and integument damage). Estimated heritability for footpad dermatitis has been reported as ≤ 0.02 (Quinton et al., 2011), 0.10–0.15 (Kapell et al., 2017) and 0.05–0.16 (Kapell, 2019) depending on lines and environments. Low to moderately unfavourable genetic correlations exist with body weight (Kapell, 2019). While this suggests that a relatively large proportion of the variation is explained by environmental factors, genetic selection for FPD is possible and has been incorporated in commercial breeding programmes in turkeys (Neeteson et al., 2023). By excluding turkeys with excessive water consumption (creating wet litter), and turkeys with a higher tendency to develop FPD, from reproduction, Neeteson et al. (2023) showed a decrease in the average FPD score in turkeys in the pedigree environment from approx. 2.7 in 2011 to 1.5 in 2022 (FPD scored from 0 to 4, with a lower score indicating better footpads). Comparisons can be made between the pedigree and sib-test environment, where siblings of pedigree selection candidates are tested in conditions closer to the commercial situation than the pedigree environment. In broiler chickens, birds showed a higher prevalence of FPD in the sib-test environment compared to the pedigree environment (Kapell et al., 2012). The authors also evaluated the predicted yearly genetic trend to selection in four genetic lines for improved FPD and body weight only. Depending on the genetic line, they showed a reduction in the average footpad score in the pedigree (reduction of 3.4 to 7.5% depending on the genetic line) and in the sib-test environment (reduction of 0.5 to 6.6% depending on the genetic line) (Kapell et al., 2012). In reality, the selection index would include a larger range of traits, including growth, lifetime performance, reproduction, liveability and health (Kapell et al., 2012). While no scientific literature was found replicating these findings in turkeys, it may be assumed that comparable progress could be made in turkeys, however this should be investigated to be certain. It is unknown how the genetic improvement in lower FPD scores observed in pedigree and sib-test translates to improvements in the commercial fattening production systems with higher stocking density, larger group size and where litter conditions may be worse (e.g. high litter moisture).

Litter moisture is a main factor in the development of FPD (Soft tissue lesions and integument damage; Section 3.2.1). In breeding programmes, the indirect measure of water consumption is used to avoid birds with excessive water consumption (Burnside & Ralph, 2024 personal communication; Neeteson et al., 2023). Rusakovica et al. (2017) estimated heritabilities between 0.09 and 0.50 for eight different drinking behaviour traits in two genetic lines of turkeys. There were low genetic correlations between traits associated with water use and drinking behaviour and performance traits, but Rusakovica et al. (2017) were unable to investigate relationships with traits such as FPD. To the best of our knowledge, it has not been investigated whether selection for drinking traits or water consumption also leads to differences in litter moisture.

While leg health and walking ability are directly associated with the welfare consequences Locomotory disorders (including lameness), Restriction of movement and Soft tissue lesions and integument damage, other aspects of turkey behaviour may be affected as well if walking is impaired. This implies that selection for improved leg health and walking ability may reduce the prevalence and severity of welfare consequences such as Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour and also Prolonged hunger and Prolonged thirst.

3.2.15.2.4 | *Injurious pecking behaviour*

Genetic selection for behavioural traits is limited, and typically non-behavioural measurements are used as proxies due to the difficulty in collecting behavioural phenotypes.

An important area of interest is genetic selection against injurious pecking (Group stress, Soft tissue lesions and integument damage), which has been suggested as a way to control this behaviour in poultry (Dalton et al., 2013; Nicol et al., 2013). Birds are selected with a reduced tendency to peck or be pecked (Nicol et al., 2013) and in laying hens there have been successful selection experiments with diverging levels of feather pecking and cannibalism (Rodenburg et al., 2008). Recent developments in automated systems to record the behaviour of individual animals can aid in the large-scale phenotyping required for genetic selection (Brito et al., 2020). While, to the best of our knowledge, no reports are published on genetic selection against injurious pecking in turkeys, breeding companies are working on this aspect and have recently included pecking behaviour in breeding programmes (Burnside & Ralph, 2024 personal communication).

The interest in selecting animals with less propensity to develop injurious pecking behaviour is, however, an example of changing the animal to suit the environment instead of the other way around. There are ethical considerations to this, as it could arguably lead to animals which are generally less reactive or animals that do not show behavioural signs of low welfare (D'Eath et al., 2010). These are considered beyond the scope of this SO, however, it should be noted that other management strategies to prevent or mitigate injurious pecking are discussed (e.g. Section 3.2.2).

3.2.15.2.5 | *Unfavourable relationships between traits*

Genetic selection and breeding strategies can impact different welfare consequences. In the case of an unfavourable relationship between two traits, improvements in one trait are associated with worsening in the other correlated trait. Breeding companies have to overcome this antagonism between traits if they want to simultaneously change both traits in the desired direction (Burnside & Neeteson, 2025). A main hazard, thus, is 'over-emphasising increased productivity', without considering the relationships with other traits. This may lead to a breeding goal which is unbalanced or unintentionally increases the occurrence of specific welfare consequences due to genetic correlations between traits.

In particular, genetic selection for increased productivity (e.g. body weight, growth rates and breast muscle) has been suggested to lead to welfare issues (Erasmus, 2018 retrieved from EFSA Public call for evidence 2024 - PC-0741 3 - Compassion in World Farming Brussels (CIWF EU)). Rapid gain in body weight is associated with bone, cartilage, tendon and ligament of poor structural quality and low tensile strength, and high body weights place additional mechanical stress on the skeletal structure (reviewed by Whitehead et al., 2003). While negative associations between growth traits and walking ability or leg disorders have been shown (e.g. Kapell et al., 2017; Mulim et al., 2024; Quinton et al., 2011), there appears to be variation in direction and magnitude (e.g. Neeteson et al., 2023), and there may be a non-linear relationship between, e.g. body weight and walking ability (Soyalp et al., 2023). To deal with these unfavourable relationships between traits, breeding companies rely on the variability that allows selection of individuals that have superior genotypes for both traits and the use of selection indexes to account for multiple traits simultaneously (e.g. Hocking, 2014; Kapell et al., 2017; Neeteson et al., 2023; Quinton et al., 2011). Neeteson et al. (2023) explain this process in broiler chickens. While there is a general unfavourable relationship between, e.g. leg strength and body weight, by simultaneously selecting birds that show the desirable combination of both traits, breeding companies can achieve a favourable trend over time. This may mitigate Locomotory disorders (including lameness) and improve leg health in a portion of the turkey population, however the unfavourable relationship remains.

Lastly, reports that show the impact of genetic selection on welfare of turkeys are limited and based on data collected in breeding programmes (Neeteson et al., 2023; e.g. van Staaveren et al., 2022). It is therefore not always clear to what extent genetic selection leads to changes in welfare conditions at the various levels in turkey production (e.g. pedigree or commercial level). This limits independent quantification of the level of genetic improvement (EFSA AHAW Panel, 2010). Independent recording of welfare outcomes to evaluate changes over time and making these data publicly available has been recommended (EFSA AHAW Panel, 2010; Hocking, 2014). Brito et al., 2020 highlighted that selection for welfare traits is unlikely to solve all welfare issues, but should instead be seen as a complementary approach to other strategies (e.g. management strategies).

3.2.15.3 | *Mitigation measures*

To prevent the hazard of 'over-emphasising increased productivity', breeding companies would need to select less intensely for production traits. While breeding companies do not solely focus on production, and have taken initiative to incorporate traits related to animal health and welfare, it is unlikely to expect that production traits will be considered of lesser importance as they remain economically relevant traits. Therefore, the hazard 'over-emphasising increased productivity' can only be limited and the related welfare consequences mitigated. This can be done by firstly including (more) welfare traits in the breeding goal, and secondly by increasing the relative weight of the welfare traits and reducing the relative weight of the production traits in the breeding goal.

In order for welfare traits to be included in the breeding goal, it is important that traits are clearly defined and measurable, and that large-scale phenotyping of welfare traits is possible. New technologies that can aid in automated phenotyping are in development. This may then lead to a direct reduction in the risk of welfare consequences through more balanced breeding. However, selection for welfare traits always needs to be seen as complementary to improved housing and management strategies (Brito et al. (2020).

Hocking (2014) argued that unexpected consequences of genetic selection are inevitable. As genetic correlations between traits exist, selection may influence multiple aspects of turkey welfare, sometimes in unforeseen ways. These genetic correlations should be identified, and causal relationships between traits should be considered in turkey breeding programmes (Abdalla et al., 2021). Additionally, improved statistical modelling can aid genetic selection decisions and increase the accuracy of breeding values. As relationships between traits become clearer, the welfare consequences become clearer as well, breeding companies can make more informed choices to balance the breeding goal.

Handling stress caused by the hazard 'inappropriate handling' during the collection of traits or blood samples can be mitigated by proper training of the staff involved in the handling of turkeys. In addition, the measurement of multiple traits at the same time can also reduce the number of times birds need to be handled and consequently reduce the handling stress.

3.3 | **ABMs collected at the slaughterhouse to assess the level of welfare of turkeys on farm**

3.3.1 | **Results of the consensus exercise**

Of the 20 identified ABMs for meat and breeding turkeys potentially relevant to collect in slaughterhouses for monitoring the level of welfare on farms, 13 passed a first screening procedure (see Table 2) and were considered in the selection step (see Figure 8).

The outcome of the semiquantitative selection exercise is presented in Table 14, where the specific scores for the four criteria (described in 2.2.3) to select the ABMs at slaughter are reported. A final six ABMs were selected, and these included total mortality on farm, plumage damage (after bleeding and before scalding), carcass condemnations, wounds, breast blisters and footpad dermatitis, chosen as the most useful ABMs collected at slaughter to measure welfare of turkeys on farm.

The ABMs dirtiness before scalding, breast buttons and bruises were not selected because they covered similar welfare consequence as other ABMs, which were more relevant. Dirtiness before scalding was not selected as an ABM because it is linked to similar, and no more, welfare consequences as the ABM Footpad dermatitis (e.g. Soft tissue lesions and integument damage, Restriction of movement, Resting problems). In addition, dirtiness before scalding is more related to the transport conditions than footpad dermatitis. The ABM bruises was not selected because the associated welfare consequences (e.g. Soft tissue lesions and integument damage, Group stress) are also covered with the selected ABM wounds. Similarly, breast buttons were not selected because the ABMs footpad dermatitis and breast blisters already covered the same welfare consequences. The ABM fractures was not included as it would be difficult to identify old fractures of bones, and new fractures may not originate from the farm conditions.

TABLE 14 Ranking of ABMs assessed at slaughter of turkeys on the basis of four criteria. The scores range from 0 to 4, with 0 indicating an absence of relationship and 4 the highest value of the relationship. The weighted score is also presented. The final selected ABMs are italicised.

ABM	Time of assessment	C1: Link to welfare consequences on farm (weight = 6)	C4: Technology readiness (weight = 2)	C2: Already measured at slaughter (weight = 1)	C3: Importance rated by the AHAW and NCP networks (weight = 1)	Weighted score
<i>Footpad dermatitis</i>	Post-mortem	3	4	4	4	3.4
<i>Total mortality on farm</i>	Ante-mortem	3	1	3	4	2.7
Dirtiness before scalding	Post-mortem	3	2	1	2	2.5
<i>Wounds</i>	Post-mortem	2	2	2	4	2.2
<i>Carcass condemnations</i>	Post-mortem	2	1	2	4	2.0
<i>Breast blisters</i>	Post-mortem	2	2	1	2	1.9
Breast buttons	Post-mortem	2	2	1	2	1.9
Bruises	Post-mortem	2	2	1	2	1.9
<i>Plumage damage (after bleeding, before scalding)</i>	Post-mortem	2	1	1	2	1.7
Fractures	Post-mortem	1	2	2	4	1.6
Eye condition (before scalding)	Post-mortem	1	0	0	1	0.7
Hock burn	Post-mortem	1	2	1	2	1.3
Swollen toes ^a	Post-mortem	1	0	0	3	0.9

^aABM added to the initial list by the EFSA experts during group discussion in step (i), the screening.

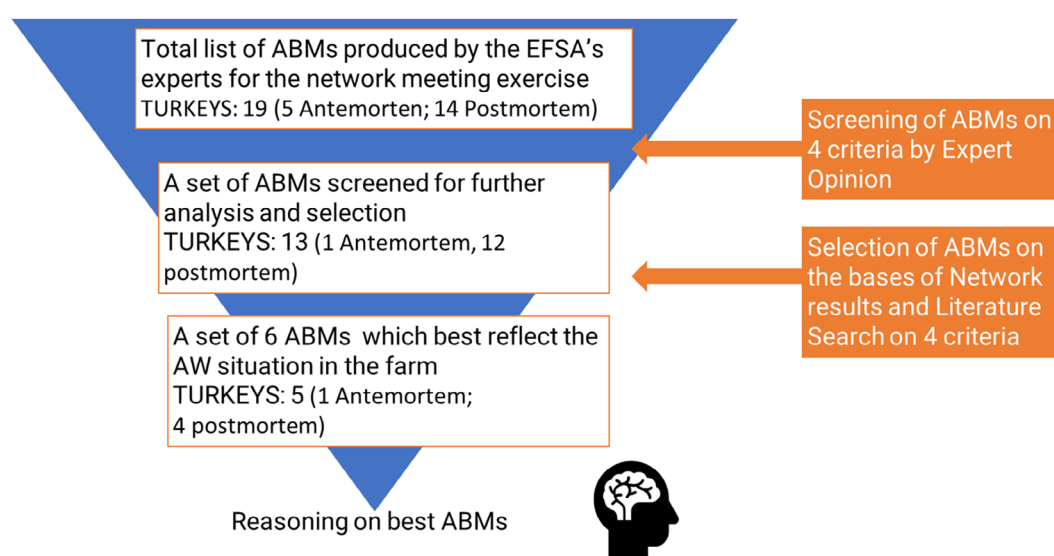


FIGURE 8 Flowchart of the consensus exercise leading to the selection of the ABMs that were considered to best reflect the animal welfare situation in the farms of turkeys. ABMs, animal-based measure.

In the following sections, each of the selected ABMs is described with its definition (as reported in EFSA (2023), interpretation, means of assessment and arguments for the selection (linking the scores and the scientific evidence in the literature).

3.3.2 | Footpad dermatitis

3.3.2.1 | Description of footpad dermatitis

Footpad dermatitis (FPD), also known as pododermatitis, was first reported in broiler chickens in the 1980s (Greene et al., 1985; McFerran et al., 1983). A similar condition has been reported in turkeys as covered by Mayne (2005). Footpad dermatitis is a form of contact dermatitis and is characterised by inflammation and necrotic lesions, ranging from superficial to deep, on the plantar surface of the footpads and toes (Stracke et al., 2021). These alterations may appear in the first few days of life, starting as broken epidermis/skin or hyperkeratosis (Shepherd & Fairchild, 2010). This may represent a starting point for local inflammation (dermatitis) that can develop into severe erosions and ulceration, and potentially secondary bacterial infections and lameness (Clark et al., 2002; Erasmus, 2018).

3.3.2.2 | Interpretation

A high incidence of FPD is associated with the on-farm welfare consequences Soft tissue lesions and integument damage, Restriction of movement, Locomotory disorders (including lameness), Gastroenteric disorders and Resting problems.

FPD has been reported to be associated with pain in turkeys (Hocking & Wu, 2013; Sinclair et al., 2015; Weber Wyneken et al., 2015). It is used as an ABM in research and in commercial conditions, mainly at slaughterhouses (Watanabe et al., 2013), providing information about the birds' physical integrity and husbandry (Stracke et al., 2022). Severe FPD lesions compromise the skin's protective barrier, increasing the risk of secondary bacterial infections, such as *E. coli* and others responsible for arthritis (Nolan et al., 2020; Shepherd & Fairchild, 2010).

FPD is strictly linked to the litter quality in the barn and is therefore relevant to the turkey industry in the EU, as almost all fattening turkeys are kept in floor systems with litter. Wet and poor quality of litter can lead to FPD (Freihold et al., 2019; Krautwald-Junghanns et al., 2011). Sub-optimal management practices, like ventilation or diet composition, play a role in the onset and progression of FPD (Krautwald-Junghanns et al., 2013; Martrenchar et al., 1999; Mayne, 2005). Studies reported that a higher stocking density is associated with a higher incidence of FPD (2001; Martrenchar et al., 1999; Noll et al., 1991; Wu & Hocking, 2011) (Hafez & Hauck, 2005). Long periods of inactivity in turn predispose the birds to pathological changes in the integument, especially FPD. Lack of enrichment in the barn exacerbates the issue (see Section 3.2.2).

Development of FPD is a dynamic process over time (Youssef et al., 2011). Therefore, the most informative link to FPD recorded at the slaughterhouse would be to have records of the litter quality, regularly throughout the production period. Toe-trimmed turkey hens have a higher predisposition to FPD compared to turkey hens with intact toes, potentially due to reduced ability to scratch up the litter, which leads to poorer litter quality (Vincio et al., 2019).

FPD is a widespread problem in commercial turkey flocks (Ekstrand & Algers, 1997; Krautwald-Junghanns et al., 2011; Leishman et al., 2021; Marchewka et al., 2020; Martrenchar et al., 1999, 2002; Shepherd & Fairchild, 2010; Toppel et al., 2019). Even in organic turkey production systems, footpad dermatitis remains a significant concern. For example, Freihold et al. (2019) found that 97.7% of organic turkeys exhibited varying degrees of FPD, with extensive necrotic lesions (> 2 cm in diameter) observed in 29.8% of the toms and 12.4% of the hens.

Sex differences in the occurrence of FPD have been observed, with hens more frequently and severely affected than toms under both conventional (Krautwald-Junghanns et al., 2011) and organic farming conditions (Freihold et al., 2019). This disparity is primarily attributed to the higher stocking density of hens in terms of hens/m², which results in increased excreta production and consequently elevated litter moisture levels, a key factor contributing to FPD (Freihold et al., 2019; Krautwald-Junghanns et al., 2011).

Available studies examined FPD prevalence has been examined at the slaughterhouse in various studies. In Germany, epithelial necrosis by the 16th week of age was present in 60% of hens and 33.8% of toms, with nearly all birds at slaughter exhibiting some level of skin alteration (Krautwald-Junghanns et al., 2011). In France, a study found that 40.7% of turkey flocks had severe FPD, indicating a widespread welfare concern (Allain et al., 2013). In Canada, FPD prevalence ranged widely from 10% to 67%, with a median prevalence of 27% across flocks (Leishman et al., 2021). FPD prevalence is influenced by seasonal variations. Higher prevalence of FPD is often reported during colder seasons, such as winter and autumn, due to increased barn humidity and reduced ventilation efficiency (Da Costa et al., 2014). Extreme weather conditions outside the barn may indirectly affect litter moisture in the barn by altering ventilation requirements and reducing air exchange efficiency (Mayne, Else, & Hocking, 2007).

Turkeys kept indoors have been reported to be generally more often affected by FPD, whereas turkeys kept under organic systems were reported to exhibit more severe lesions (Freihold et al., 2019). In addition to the factors influencing FPD in both conventional and organic systems, mandatory outdoor access in organic production has been linked to development of FPD, as wet and muddy conditions promote footpad inflammation (Freihold et al., 2019). Additionally, longer rearing periods on the same litter and dietary imbalances, caused by organic farming restrictions on synthetic nutrients, can lead to poor litter quality and increased moisture, further contributing to FPD development (Freihold et al., 2019).

3.3.2.3 | *Assessment of footpad dermatitis*

Timing of assessment at slaughter: Post-mortem

FPD assessments may be carried out at the farm (Krautwald-Junghanns et al., 2011) or at the slaughterhouse (Allain et al., 2013; Hocking et al., 2008). However, footpad lesions are easiest observed at the slaughterhouse (no manipulation of live animals, lesions more visible after cleaning the feet) and it provides an insight into the cumulative welfare of turkeys at the end of the fattening period for turkeys kept for meat production and at the end of the production for turkey breeders. At slaughterhouses, FPD is often scored by visual inspection as part of post-mortem welfare assessments, providing insights into the conditions the birds experienced on the farm. This retrospective evaluation enables slaughterhouses to benchmark the welfare practices of their suppliers. Poor FPD scores observed at slaughterhouses can instigate farm audits or corrective measures aimed at improving on-farm management to the benefit of the welfare of future flocks (Marchewka et al., 2020; Vasdal et al., 2021).

Current use of FPD as ABM at slaughter

FPD is considered one of the most relevant animal-based indicators to evaluate turkey welfare (Sinclair et al., 2015; Watanabe et al., 2013; Weber Wyneken et al., 2015). In the absence of formal EU legislation, certification schemes and industry guidelines have stepped in to set benchmarks for monitoring and managing FPD in turkeys. Industry standards and certification schemes increasingly integrate FPD monitoring to promote high-welfare practices. Programmes such as the UK's Red Tractor Assurance and the Global Animal Partnership include FPD assessments. Some EU Member States, like Germany, have implemented systems at slaughterhouses, either based on manual inspections through visual evaluation or automated inspections through cameras, to assess the FPD prevalence in turkeys. This may include set trigger levels of FPD scores that can lead, where necessary, to actions intended to improve the welfare of future flocks (European Commission, 2025). For example, in Italy, an automatic scoring system of FPD is used for scoring the feet of all turkeys within each batch slaughtered. The scoring protocol used has five levels, i.e. from 0=no lesions to 4=serious necrosis that can reach the toes. The score is based on a formula that gives different weighting to the four levels with higher weighting as the severity of the lesions increases (European Commission, 2024a). In contrast, in a slaughterhouse in France, the prevalence of FPD is not regularly monitored due to the perceived lack of variability within the flocks as FPD generally occurs at high prevalence and severity (European Commission, 2024b). Instead, other indicators such as the swelling of the toes are considered to be more discriminant as an ABM (European Commission, 2024b).

Considerations for the use of a standard method to assess FPD

Currently, there is no consistent approach to assess FPD post-mortem in turkeys at slaughter, and different protocols exist for sampling of one or both feet, different sample sizes of birds and scoring schemes (Toppel et al., 2019).

Manual assessment of the severity of FPD is based on an evaluation of the area of the alterations of the footpad. The scoring system used in turkeys was developed by Hocking et al. (2008) and is a 5-step visual scoring system based on the size of the colour-changed areas on the metatarsal pad.

However, this macroscopic scoring may not always accurately reflect histological findings. Studies have shown that footpads appearing normal externally can still exhibit microscopic lesions, and correlations between macroscopic and histopathological scores are often low (Mayne et al., 2006; Mayne, Else, & Hocking, 2007; Mayne, Powell, et al., 2007). For instance, Toppel et al. (2019) found that small, dark-coloured areas, typically assigned a macroscopic score of 1, can actually indicate the presence of ulcers when examined histologically, with inflammatory processes affecting both the epidermis and dermis. Additionally, the presence of granulocyte populations in these areas confirms an active inflammatory response, strongly suggesting pain. This raises concerns that the current scoring system may underestimate lesion severity, as it primarily considers size while overlooking indicators of deeper tissue damage and inflammation. Consequently, lesions assigned a lower macroscopic score might warrant higher classification based on their histological characteristics. Standard scoring systems often overlook specific alterations, such as those occurring on digital pads.

Possibility for automation of FPD at the slaughterhouse

Automation offers a promising solution for improving the efficiency, consistency and scalability of FPD scoring in turkeys, particularly in large-scale operations. Germany has been a leader in this field, with most slaughterhouses implementing automated systems to evaluate some aspects of FPD severity and FPD prevalence based on standardised scoring systems which calculate the proportion of necrotic areas relative to the metatarsal pad (CLK GmbH; Turkey Check V1.0, Altenberge, Germany) (Stracke et al., 2022).

While automation reduces labour and minimises observer bias, it faces challenges, including difficulty detecting lesions on digital pads or distinguishing scar tissue from active necrotic areas and different severity levels (Stracke et al., 2021;

Toppel et al., 2019). Toppel et al. (2016) emphasised the importance of incorporating more detailed assessments. Moreover, no consideration of the lesion depth is currently included in the automated FPD evaluation systems.

3.3.3 | Total mortality (on farm)

3.3.3.1 | Description of total mortality on farm

The mortality rate, or death rate, is a measure of the number of deaths in a particular population, scaled to the size of that population, per unit of time (EFSA AHAW Panel, 2023a). It can be calculated in different ways. The daily mortality rate is the number of turkeys which have died in the house on the same day, including those that have been culled either for disease or other reasons, divided by the number of turkeys present in the house on that day. The total mortality can also be calculated by dividing the total number of dead and culled birds by the number of birds placed in the barn or sent to slaughter. Total cumulative mortality determined at the end of the production cycle is more precise since it gives information on the total number of dead animals and on the proportion of dead/culled animals over time. The cumulative daily mortality rate is the sum of all daily mortality rates up until the specified date or age (calculation is detailed for broiler production using the same method as in EURCAW Poultry SFA, 2023b). Having the possibility to distinguish (through separate registration) between the number of birds found dead and those that are culled is important. Indeed, culling birds for welfare reasons is a way to reduce negative affective states of suffering animals. However, high proportions of birds culled (outside depopulation) may also indicate important health or welfare issues in the flock. Total mortality is collected on farm and communicated to the slaughterhouse with the vehicle transporting the birds.

3.3.3.2 | Interpretation

Many factors will affect total mortality on farm, which includes early mortality as well as mortality occurring during the remaining production period. Early mortality refers to 7-day mortality in some cases (Roehrig & Torrey, 2019) and to 14-day mortality in others (Carver & Barnes, 2000). Early mortality rates during the first week of life may reach 6% in turkey flocks (Carver & Barnes, 2000; Christensen & Davis, 2003; Ross, 2016) and may be affected by several endogenous factors including biological age, genetics, development of the digestive tract at hatch, sex and yolk sack size (Roehrig & Torrey, 2019). Biological age, defined as the age at hatch from the time of egg placement, can range from 26.5 to 28.5 days, meaning some poults remain in the hatcher 36–48 h longer than others. Earlier hatched poults (those having lower biological age) may suffer higher mortality, being more prone to bacterial infections (yolk sac infection) due to their extended exposure to pathogens in the hatchery after hatching and increased potential of becoming dehydrated (Roehrig & Torrey, 2019). Indeed, delayed access to feed and water (e.g. in case of early hatching) may lead to dehydration (Lamot et al., 2014), mortality (if low egg weight) (Moran Jr., 1990) and changes to metabolic functioning (Turner et al., 1999). The risk of the latter has been reported to double for poults placed on farm 24 h as compared to those placed 6 h after hatch (Moran Jr., 1990).

Locomotor disorders (including lameness; Glatz & Rodda, 2013 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Djurens Rätt), heat stress (Sake et al., 2024), dehydration and cannibalism (van Staaveren et al., 2020) as well as outbreaks of disease such as Gastro-intestinal disorders (Shehata et al., 2021) have been reported to be the main causes of mortality in turkeys. Reporting the causes of death is informative for welfare evaluation. Mortality can be caused by injuries (e.g. injurious pecking or accidental injuries from the housing system). If piling of birds occurs, the number of birds that died by suffocation should be counted and recorded as a specific type of mortality. In free-ranging flocks of birds, predation can also be a cause of mortality and it is recommended that missing birds are reported in addition to mortality (EFSA AHAW Panel, 2023b). Reasons for culling that may be related to poor welfare of turkeys on farm include leg deformities and leg injuries, undersized birds (runts), cannibalism and pecking injuries (van Staaveren et al., 2020).

Many different welfare consequences can lead to mortality and the higher the severity and/or prevalence of the welfare consequence, the higher the mortality observed. Even if a bird does not die from a particular welfare consequence, it may be necessary to cull it for welfare concerns. In both cases, it is the discomfort, pain and fear experienced by the bird before it dies or is culled that is of welfare concern.

In summary, the higher the level of on farm mortality, the higher the probability that there have been welfare issues on farm. Total mortality is considered an iceberg indicator because it is related to many relevant welfare consequences (Heat stress, Prolonged hunger, Prolonged thirst, Predation stress, Sensory under- and/or overstimulation, Soft tissue lesions and integument damage and Gastroenteric disorders). Further investigation into the causes of mortality or culling is necessary to identify the actual hazards and mitigate welfare consequences or prevent them for future flocks on the farm.

3.3.3.3 | Assessment of total mortality (on farm)

Timing of assessment at slaughter: ante-mortem

The total mortality of turkeys on farm is communicated to the slaughterhouse (European Commission, 2024a, 2024b). The official veterinarian checks the values of on-farm mortality for each batch of turkeys, and in case of excessive mortality, measures may be taken, depending on the EU Member State.

Current use of total mortality on farm as ABM at slaughter

Literature reported total mortality on farm (including culled birds; %) to be registered and communicated to the slaughterhouses (Marchewka et al., 2020; Vasdal et al., 2021). The data on mortality is collected from placement until the time the flock leaves the farm and is provided separately from the data on dead on arrival at the slaughterhouse. Currently the data on number of birds culled is not always provided separately from the number of birds dying spontaneously on farm.

Considerations for use of a standard method for assessing total mortality

Total mortality is routinely measured and used as a production index in the turkey industry. Increased early mortality may be attributed to several endogenous and exogenous factors which may reflect age and condition of breeder stock and conditions at the hatchery, during transport to the brooding and rearing facilities and/or on the farm. If reasons for total mortality are not known, it may therefore be difficult to determine where to make improvements. It has to be noted that total mortality is a declarative indicator not easy to verify for an external assessor.

A significant association has been observed between higher mortality and increased average carcass weight at slaughter, as well as more birds rejected (Marchewka et al., 2020).

Possibilities for automation of total mortality at the slaughterhouse

Although the number of dead and culled turkeys on the farm will continue to be recorded manually, an increasing number of autonomous robots is currently used to report mortalities throughout the barn. As an example, a robot is now used in commercial turkey barns, not only for daily registration of mortalities, but also litter tilling and water and feed anomaly detection and notification, which may help monitoring mortality and identifying risk factors for compromised welfare (Poultry Patrol, [online](#)).

Even when mortality is manually recorded for each flock, it is important that cumulative mortality rate (and ideally causes) is integrated in a database, so that mortality can be monitored in all the EU Member States. In the future, a warning system based on early detection of mortality increases can be a promising tool to monitor and mitigate welfare issues in turkey production.

3.3.4 | Plumage damage (after bleeding and before scalding)

3.3.4.1 | *Description of plumage damage*

Deterioration or loss of plumage includes damaged feathers or feather loss. The AWIN protocol for turkey welfare assessment (AWIN, 2015) uses the ABM featherless to describe turkeys having one or more visible areas of missing feathers on the body. A turkey is considered featherless when it has missing feathers on an extended area on the back, or back and wings, but this scoring system is not precisely defined.

3.3.4.2 | *Interpretation*

Plumage damage is related to the welfare consequence inability to perform exploratory or foraging behaviour. If exploratory and foraging behaviour is thwarted, then development of injurious pecking may occur and consequently result in soft tissue lesions and integument damage and Group stress (EFSA AHAW Panel, 2023b). An increasing number of turkeys with missing feathers may also reflect inadequate housing conditions. After the initial loss of feathers, pecking may also lead to injuries (see Section 3.3.6). Pecking injuries to the head/neck area and back/tail area in turkeys can be used as proxies for aggressive and feather pecking, respectively (Leishman et al., 2022).

3.3.4.3 | *Assessment of plumage damage*

Timing of assessment at slaughter: post-mortem

Plumage condition is mainly assessed on-farm and can also be carried out post-mortem after bleeding and prior to scalding. Plumage damage assessment at slaughter has been developed by EURCAW-Poultry-SFA for laying hens (EURCAW Poultry SFA, 2024b) to be performed on the slaughter line from a dorsal view of the birds before scalding. A similar system for assessment of plumage damage could be developed for turkeys and could easily be combined with wound assessment on the slaughter line.

Current use of plumage damage as ABM at slaughter

According to EFSA (2023), four countries (out of 17) reported that they assessed plumage damage in turkeys post-mortem at slaughter through visual observations.

Considerations for use of a standard method for assessing plumage damage

Any manual or automated scoring method used to assess the plumage damage should allow for a clear identification of specific body areas. Today, the AWIN protocol (AWIN, 2015) is available to visually score whether there are birds with missing feathers that can be used as a proxy to assess plumage damage (assessing only the back and wings) on farms using the transect walks. Dalton et al. (2016) assessed the plumage damage of turkey toms between 11 and 21 weeks of age. The neck, back, wings and tail regions were each scored using a 6-point feather scoring scheme developed from Morrissey et al. (2014). They used a 0–5 scoring system combining missing feathers and tissue damage (0 = no plumage damage, and $5 \geq 50\%$ feathers missing from an area with blood or tissue damage) for scoring female broiler breeders between 10 and 36 weeks of age. This supports the approach to aggregate feather damage with pecking wound assessment in turkeys.

Grün et al. (2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Four Paws) assessed plumage damage in turkeys with different beak treatments between 9 and 20 weeks of age. They used a 0–3 simple scoring system based on the surface of featherless area (from 0: no featherless area to 3: ≥ 10 cm featherless area) on the back and wings. Olschewsky et al. (2021 retrieved from EFSA Public call for evidence 2024 - PC-0741 2 - Deutscher Tierschutzbund e.V.) studied fast and slower growing turkeys between 7 and 25 weeks of age for plumage and skin damage combined with a 0–4 scoring system (from 0: no feather damage to 4: damaged feathers or bare skin larger than 10 cm in diameter). These systems based on evaluation of the area of missing and/or damaged feathers, sometimes in combination with skin injuries, have been used for on farm assessment but could be transferred to slaughterhouse use, providing a validation of the correlation of scoring on farm and at slaughter.

Possibilities for automation of plumage damage at the slaughterhouse

To the best of our knowledge, assessing plumage damage in turkeys in an automated way at the slaughterhouse is currently not explored. A method that would involve image analysis of the dorsal area of the turkeys on the slaughter line would be a practical option. Based on the results from Lamping et al. (2022) studying laying hens on farm, the expert opinion is that it is possible to develop a method for automatic assessment of RGB images (i.e. images where each pixel is defined by the amount of red, green and blue colours) from the slaughter line (before scalding) that can be used to assess plumage condition.

3.3.5 | Carcass condemnations

3.3.5.1 | Description of carcass condemnations

Carcasses or parts of the carcass that are unfit for human consumption and therefore removed and condemned. They can be described as the number of birds, the weight of the carcasses or parts of carcass per group of slaughtered birds. Carcass condemnations can be due to e.g. septicaemia, hepatitis, pericarditis, abscesses, arthritis, emaciation, pneumonia, pleurisy, pleuropneumonia, congestion or runts found post-mortem. This list is not exhaustive, as condemnation might occur for many other reasons (EFSA AHAW Panel, 2023a).

According to the Commission Implementing Regulation (EU) 2019/627,¹⁹ all slaughterhouses throughout the EU record carcass condemnations (including the part of the carcass condemned if only partially condemned). The reason for condemnation is recorded primarily for food hygiene and meat inspection purposes. Apart from carcass contamination (e.g. with intestinal contents during evisceration) during the slaughter process, the other reasons for trimming or condemning a carcass are linked to welfare-relevant conditions.

3.3.5.2 | Interpretation

The conditions that have led to (partial) condemnation of turkeys during meat inspection may have affected the animals' welfare when the turkeys were still alive in any of the stages prior to slaughter, i.e. including on farm and during transport and lairage (Blomvall et al., 2023). Common carcass condemnation reasons in turkeys are reported to be generalised congestion, cachexia, non-purulent cutaneous lesions and arthritis–polyarthritis (Blomvall et al., 2023; Salines et al., 2017), abscesses, skin conditions such as breast blisters (hygromas) and purulent bursitis (Mitterer-Istyagin et al., 2011), back wounds (Marchewka et al., 2015) and skin injuries (Blomvall et al., 2023; Salines et al., 2017). The prevalence of leg disorders has also been found to be highly correlated with the prevalence of condemnations (whole or part) and other carcass quality indicators (Marchewka et al., 2015).

The overall condemnation rates of turkey carcasses in the different EU Member States are not available. However, a study conducted in France reported the overall condemnations rate of 1.85% (Salines et al., 2017). Others have reported a total condemnation rate of 1.80% in toms from conventional systems (Lupo et al., 2010) and 1.27% in hens (Salines et al., 2017).

¹⁹Commission Implementing Regulation (EU) 2019/627 of 15 March 2019 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council and amending Commission Regulation (EC) No 2074/2005 as regards official controls. OJ L 131, 17.5.2019, pp. 51–100.

Higher whole and partial carcass condemnation rates have been found in toms as compared to hens (Blomvall et al., 2023), which may be attributed to their longer fattening period and higher body weight (Salines et al., 2017). The enlarged sternal bursa (Blomvall et al., 2023) and breast skin lesions (Mitterer-Istyagin et al., 2011) have been found to be the most common reasons for whole carcass condemnations in tom flocks.

The higher the rates of condemnations, the more likely the existence of welfare-related issues on the farm (EFSA AHAW Panel, 2023a). Carcass condemnation is considered an iceberg indicator because it may be related to different welfare consequences on farm such as Bone lesions (including fractures), Gastroenteric disorders, Locomotory disorders (including lameness), Metabolic disorders, Respiratory disorders, Skin disorders and Soft tissue lesions and integument damage.

3.3.5.3 | *Assessment of carcass condemnations*

Timing of assessment at slaughter: post-mortem

Current use of carcass condemnations as ABM at slaughter

The required recording of carcass condemnations has been progressively used as a relevant source of data to monitor animal health and welfare conditions (Huneau-Salaün et al., 2015; Stärk et al., 2014). Carcass inspection is performed by the official veterinarians (Freihold et al., 2021).

The calculation unit of condemnation rates is variable, being sometimes expressed in terms of weight and sometimes in terms of number or percentage of birds per flock. For instance, the Global Condemnation Rate, including both total and partial condemnations, has been reported in some studies (e.g. Salines et al., 2017) as the percentage of carcasses condemned per flock. When separated, the Total Condemnation Rate is calculated as the percentage of fully condemned carcasses, whereas the Partial Condemnation Rate (corresponding to carcasses that were partially condemned) is calculated as either the weight of the rejected body parts or number of carcasses (Salines et al., 2017). Hence, the variability of the used unit, in addition to other issues such as variability of the names of lesions or conditions as the reason for condemnation, is hampering the comparison of data between different EU Member States and/or slaughterhouses (Salines et al., 2017).

There is little available information on the use of condemnation data for animal welfare purposes. Turkey flocks exhibiting clear health and welfare issues, such as leg problems, can be identified based on their food chain information (Annex II, Section III of Council Regulation (EC) 853/2004), but this information has so far only been used in relation to risks to meat safety (Blomvall et al., 2023). High levels of carcass condemnation can be used as a proxy of poor welfare, assuming that severe lesions or poor body condition (i.e. emaciation) caused negative affective states such as pain and/or discomfort in the bird while alive. However, as condemnation assessment addresses only the cases that are relevant for human food safety and is only based on the birds sent for slaughter, low or expected levels of carcass condemnation may not necessarily reflect good welfare on farm (EFSA AHAW Panel, 2023a).

Considerations for use of a standard method for assessing carcass condemnations

Turkey carcass condemnation relies on a visual macroscopic post-mortem inspection, which may vary depending on the person inspecting the carcass (Salines et al., 2017). However, the level of agreement (Kappa) between inspectors of poultry carcasses has been reported to vary between 0.51 and 0.62 (out of a maximum of 1) and the positive predictive value to be between 60% and 70% (Bisaillon et al., 1988), which highlights the influence of personal judgement in visual post-mortem inspection of poultry carcasses. Moreover, in a large study performed in France, the results showed a major impact of the slaughterhouse on the associations between reasons for condemnations, stressing the need to improve the training of inspectors to enhance the accuracy of reasons for condemnation (Salines et al., 2017). A harmonised methodology at the slaughterhouse level to jointly investigate the rates, criteria and reasons for condemnations is also required to allow comparison between slaughterhouses and the EU Member States (Salines et al., 2017).

Possibility for automation of carcass condemnations at the slaughterhouse

Decisions on carcass condemnation are made after inspection by the official veterinarians, and the possibility for automation has been estimated by experts to be low. Currently there is a prototype vision system (IRIS GDR; Marel) mainly used for chicken carcass classification. It measures weight, yield of whole bird and different body parts and identifies the carcass or parts of the carcass to be condemned. This system supports the official veterinarian in condemnation decisions by measuring different defects (e.g. bruises, fractures, scratches). However, information on the validation of this tool is not publicly available (BuRO, 2022).

In Germany, a prototype camera to detect deep dermatitis on the carcass and ascites in broiler chickens is supporting the official veterinarians in their assessments of carcass condemnations (EFSA AHAW Panel, 2023a). The same prototype has been tested in turkeys, but is currently not validated (Berk, 2025, personal communication).

The development of automated and harmonised recording of carcass condemnations and electronic databases to store this information may support animal welfare monitoring schemes across different slaughterhouses/EU Member States.

3.3.6 | Wounds

3.3.6.1 | Description of wounds

Wounds are soft tissue lesions with or without rupture of the skin. They comprise all types of damage to the skin, ranging from scratches to large open wounds that go deeper than the skin (adapted from Welfare Quality Network, 2019). It also includes pecking injuries and bruises. It does not include bone lesions, wing fractures, beak issues or foot injuries (EFSA AHAW Panel, 2023a).

3.3.6.2 | Interpretation

Wounds is an ABM for Soft tissue lesions and integument damage that may be caused by several welfare consequences on farm such as Group stress (Buchwalder & Huber-Eicher, 2003; Marchewka et al., 2013; Marchewka et al., 2019), Restriction of movement, Resting problems and Inability to perform exploratory or foraging behaviour (Dalton et al., 2018). Injurious pecking encompasses three main types of pecking, including aggressive pecking, tissue pecking (or cannibalistic pecking) and feather pecking (Leishman et al., 2022). Head, neck and snood wounds result from aggressive pecking (Buchwalder & Huber-Eicher, 2003; Dalton et al., 2018; Haug et al., 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt), which is considered to be related to agonistic interactions between birds (Sherwin et al., 1999a, 1999b). Higher stocking density leads to increased aggression and hence, a higher number of birds of both sexes with head and tail base wounds (Marchewka et al., 2019). Wing, back and tail base wounds may originate from severe feather pecking, where the tissue at the base of the feathers is damaged during the pulling of the feathers and it is associated with plumage damage. The underlying cause is reported to be re-direction of ground pecks as part of foraging behaviour in environments lacking appropriate enrichment (Dalton et al., 2018). If performed on the farm, wound assessment is generally done dividing the body into regions (head/neck, back and tail base) (Ferrante et al., 2019; Marchewka et al., 2019).

For the use of the ABM wounds at the slaughterhouse, the determination of the age of the lesion is important to discriminate between lesions inflicted on the farm and those resulting from transport and pre-slaughter handling. This should be done while taking the times of catching, crating, loading, journey, unloading at the slaughterhouse, lairage and stunning and slaughter (all are routinely recorded by the companies) into account. Although no information was found regarding turkeys, early studies related to other avian species, such as broiler chickens, reported this assessment to be based on the observations of the characteristic progression of colour alteration in the damaged area (Hamdy et al., 1961). The method of these authors, applying a test with the Fouché reagent immediately after slaughtering the birds, is based on detecting the bilirubin or biliverdin which is formed during the healing process of poultry bruises as a result of the catabolism of haemoglobin present in the damaged areas. However, this method may not be performed easily under field conditions. Hence, more recent literature focused rather on visual assessment of the colour of damaged areas to determine the age of the lesion (EURCAW Poultry SFA, 2020). Bruises having a light green, yellow-green and light-yellow colour are considered to be older than 24 h and, thus, are more likely to originate from the farm. In contrast, bruises from intense dark red to purple colour were estimated to be less than 12 h old and hence, to be caused during catching and transport. Bright red bruises are considered to be caused at the slaughterhouse during shackling (EFSA AHAW Panel, 2023a). Nonetheless, relying on visual inspection of the colour to estimate the age of the lesion may present some limitations due to the fact that the bruise colour in birds is affected by location as well as variability in the perception threshold for yellow between observers, reducing reliability and accuracy for estimating bruise age older than 48 h (Hughes et al., 2004).

3.3.6.3 | Assessment of wounds

Timing of assessment at slaughter: post-mortem

Assessment of wounds post-mortem after scalding is easier and more reliable than ante-mortem or before scalding (which presents many limitations, including the presence of feathers that may hamper visibility) (EURCAW Poultry SFA, 2020). Moreover, handling live birds to check different body parts is laborious, time-consuming and stressful for the birds. Ante-mortem assessment may also be limited by feather dirtiness and environmental conditions such as poor lighting and dust (EFSA AHAW Panel, 2023a). Furthermore, it can be difficult or unfeasible to inspect each individual, especially when the birds are in a crate.

The visibility of the wounds is improved when clean carcasses are presented to the observer in a standardised way. Regardless, the presence of artefacts (e.g. wounds inflicted post-mortem during waterbath stunning or processing, like scalding) and visual limitations show that it is important to adjust any assessment protocols to the practical situation of a slaughterhouse.

Current use of wounds as ABM at slaughter

According to EFSA (2023), the majority of the network representatives, who responded to the questionnaire, recorded wounds at slaughter (14 out of 17) and used visual assessment. The same report showed that currently wounds are mainly assessed for meat quality and food safety purposes.

Considerations for use of a standard method for assessing wounds

Although no information for assessing wounds at slaughter has been found for turkeys, literature for other avian species, such as broiler chickens (EFSA AHAW Panel, 2023a) and laying hens (EFSA AHAW Panel, 2023b), reported that wound assessment post-mortem can be performed. However, the reliability and accuracy of such assessment are conditioned by the ability of the observer to differentiate between artefacts (i.e. lesions inflicted post-mortem) and wounds, and between ages of the wounds to determine their origin (i.e. farm, transport or slaughter). Hence, the staff needs to be trained in order to minimise any potential bias in the results. Thus, there is a need for a harmonised scoring system to monitor wounds post-mortem in turkeys.

Experimental studies performed on turkeys on farm reported visual scoring systems for wounds on different body areas such as the head/snood/caruncle area, neck, back (including sides of the body) and wings, and with different scales of severity (Haug et al., 2023 retrieved from EFSA Public call for evidence 2024 - PC-0741 4 - Djurens Rätt; Leishman et al., 2022). EURCAW Poultry SFA (2023) has developed a factsheet for scoring of injurious pecking damage in turkeys on farm at the main targeted areas, i.e. neck, back and tail/vent. This system can alternatively be used as a model to establish a scoring system specifically for wounds assessed on the slaughter line.

Possibility for automation of wounds at the slaughterhouse

At the slaughterhouse, wounds can be assessed on the carcass by computer vision analysis. There is already a prototype, VetInspector, made by IHFood in Denmark (www.ihfood.dk), for the post-mortem inspection of lesions in chickens (Sandberg et al., 2023). It consists of two camera stations that detect lesions on the outside of the carcass and on the viscera. The image analysis algorithm is a neural network/artificial intelligence model, where the ability to classify lesions correctly is improved with every new carcass photographed. The model is capable of analysing pictures of carcasses at any slaughter speed. Another system, the Intelligent Reporting, Inspection & Selection system (IRIS; Marel), consists of a digital camera, LED lighting and advanced recognition software that uses shape, colour and texture to detect wounds on the carcass (Marel, online). These two systems still need validation for the identification of the different types of lesions and the relationship with on-farm animal welfare.

3.3.7 | Breast blisters

3.3.7.1 | *Description of breast blisters*

Breast blisters (or keel cysts) refer to encapsulated areas of swelling of the sternal bursa, which may be filled with serous fluid (hygroma) as well as pus (bursitis sternalis) and inflammation and the periphery (Nielsen, 2004).

3.3.7.2 | *Interpretation*

Breast blisters are assumed to be caused by prolonged pressure or friction on the keel bone, leading to a fluid-filled swelling of the bursa (Miner & Smart, 1975). Breast blisters can be used as an ABM of the welfare consequences Soft tissue lesions and integument damage, Restriction of movement and Resting problems. Early studies showed that breast blisters developed primarily during later stages of the fattening cycle of turkeys (e.g. between 16 and 20 weeks (Rasplicka, 1962), between 12 and 20 weeks (Adams et al., 1967), suggesting these stages to be critical. Higher prevalence of breast blisters has been observed in turkey toms compared to hens (Blomvall et al., 2023; Mitterer-Istyagin et al., 2011), which is mainly attributed to their rapid weight gain and alterations in the skeletal system leading to decreased activity and longer periods of lying on the wet litter due to the longer production period compared to hens (Mitterer-Istyagin et al., 2011). High prevalence of breast blisters may also reflect poor litter condition in the barn (Freihold et al., 2021). Feathers are a natural protection against an irritating environment, and hence, poor feathering may also increase the prevalence of breast blisters (Hybrid, 2022; Miner & Smart, 1975).

3.3.7.3 | *Assessment*

Timing of assessment at slaughter: post-mortem

Assessment of breast blisters post-mortem after scalding is easier and more reliable than ante-mortem. The same limitations as listed for the ABM wounds are relevant for the assessment of breast blisters (see Section 3.3.6.3) (EFSA AHAW Panel, 2023a).

Current use of breast blisters as ABM at slaughter

According to the EFSA report (2023), the majority of the network representatives, who responded to the question, recorded breast blisters at slaughter (14 out of 17).

Considerations for use as a standard method to assess breast blisters

Literature showed breast blisters, in terms of skin alterations including hygroma and purulent bursitis, to be assessed and differentiated according to the degree of severity, ranging from 1 to 3 (mild, moderate and severe) (Freihold et al., 2021; Mitterer-Istyagin et al., 2011). These scores were attributed based on only visual (Freihold et al., 2021) or visual and palpatory examinations (Mitterer-Istyagin et al., 2011).

The EFSA report (2023) indicated differences regarding preferred scoring systems used to assess breast blisters at slaughterhouses among the EU Member States. For instance, some answers showed that a simple assessment system based on presence/absence of breast blisters (referred to as yes/no scoring) would be sufficient, whereas others indicated this to require a more detailed scoring system. External examination is sufficient to detect alterations and is easy to perform under field conditions (Freihold et al., 2021). Thus, there is a need for a harmonised scoring system to monitor breast blisters in turkeys.

Possibilities for automation of breast blisters at the slaughterhouse

At the slaughterhouse, breast skin assessment on the carcass can be performed by computer vision analysis. For instance, a camera-based quality control system is currently used in Germany for turkeys (GmbH). This system allows the analysis of the breast skin for bumps and the detection of skin changes using a 3D volume measurement. The validation status of this system is not known.

4 | CONCLUSIONS

Conclusions for which limited evidence was found are presented with a certainty level assessed through expert opinion.

4.1 | Conclusions on type and condition of litter

1. The relevant welfare consequences resulting from the hazards inappropriate type, quantity and condition of the litter are Resting problems, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Cold stress, Locomotory disorders (including lameness), Soft tissue lesions and integument damage and Respiratory disorders. Some of these welfare consequences may lead to Group stress, potentially causing or exacerbating injurious pecking.
2. Turkey breeders have a higher risk of experiencing litter-related welfare consequences than turkeys raised for meat production due to prolonged exposure during their longer production period.
3. The main hazard leading to inappropriate litter condition is 'too high humidity of the litter'. The specific hazards causing 'too high litter humidity' are 'inappropriate bedding material', 'inappropriate bedding and litter quantity', 'inappropriate type of floor' and 'inappropriate management of the litter'.
4. The EFSA experts are 90%–100% certain that the hazard 'too high humidity of the litter' is present when litter humidity exceeds 40% at any time during the rearing or production period.
5. The effect on welfare of litter humidity between 35% and 40% moisture is unclear.
6. The bedding material that best contributes to preventing and/or mitigating the welfare consequences related to litter type and condition is chopped straw or straw pellets. This is followed by wood shavings, with unchopped straw being less absorbent.
7. Ensuring proper drainage and regular cleaning of the floor help maintain dry flooring conditions and mitigate the buildup of harmful bacteria and ammonia.
8. Ventilation in the barn adjusted to the size and characteristics of the barn, the climatic conditions and the age, stocking density and health conditions of the turkeys prevents the hazard 'too high litter humidity'.
9. Continuous monitoring of litter quality and addition of new bedding (replenishment with the same or different bedding material) allow effective moisture absorption, reduce ammonia levels and prevent and/or mitigate the welfare consequences associated with decreased litter quality.
10. Litter turning and partial replacement of inappropriate litter with new bedding improve litter quality.

4.2 | Conclusions on type and availability of enrichment

Elevated structures for perching

1. Turkeys for meat production and breeder turkeys are motivated to perch, i.e. using elevated structures for roosting during day and nighttime.
2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of elevated structures are Resting problems, Group stress and Soft tissue lesions and integument damage.
3. Elevated structures are used to a higher extent if access is made easier by adjusting the height to fit the animal category, reducing stocking density within the barn, providing ramps and/or ensuring sufficient area of elevated structures per turkey.
4. Platforms are the best suited type of elevated structure as they are preferred by the turkeys over perches and planks, are used to a higher extent and reduce the risk of breast blisters. Strawbales may be used as elevated structures, but as they lose this function due to progressive destruction, they are only suitable as elevated structures, if replenished before this happens.
5. Turkeys use elevated structures more during nighttime than during the day, and the use varies with the age of turkeys.
6. To accommodate turkey breeder hens with an estimated body weight of 12 kg during the laying period, the minimum space allowance on elevated structures is 0.15 m²/hen for 0.60 m wide platforms and 0.35 m/hen for planks (certainty: 90%–100%).
7. The EFSA experts consider the requirement of space allowance on elevated structures to be similar for hens kept for meat production (certainty: 90%–100%).
8. There is a gap of knowledge on the space requirement on elevated structures for toms kept for meat production and breeder toms.

Foraging and exploratory material

1. All categories of turkey are motivated to use foraging and exploratory material.
2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of foraging and exploratory material are Inability to perform exploratory or foraging behaviour, Group stress, Soft tissue lesions and integument damage, and Locomotory disorders (including lameness).
3. Non-edible pecking objects, such as metal objects, strings and plastic balls, are less suitable as foraging and exploratory material and may not be as effective in preventing or mitigating the welfare consequences compared to edible pecking objects. In contrast, edible exploratory and foraging materials, such as straw, corn silage, wheat grain and pecking blocks remain attractive and appropriate as turkeys grow, resulting in higher use and prevention or mitigation of the associated welfare consequences.
4. Insufficient availability (either in time or in space) of exploratory and foraging material in the barn will increase the risk of competition and have a negative impact on the welfare consequences associated with absence of exploratory and foraging materials. However, evidence is lacking regarding the quantity of foraging and exploratory material needed to allow unhindered access for all turkeys within a commercial-sized flock for the materials to be effective in mitigating the welfare consequences.

Visual barriers

1. All categories of turkeys are motivated to use visual barriers as hides or shelters.
2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of visual barriers are Group stress and Soft tissue lesions and integument damage (certainty: 66%–100%).
3. Research addressing the quantity, distribution and design of visual barriers as environmental enrichment in turkey housing and their effects on welfare is limited.

Dust baths

1. All categories of turkeys are motivated to perform dustbathing.
2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of substrate suitable for dustbathing or specific dust baths are Inability to perform comfort behaviour and may lead to Group stress and Soft tissue lesions and integument damage.
3. Research addressing the effects of quantity and distribution of dustbaths on Inability to perform dustbathing is limited in turkeys.

Complex enrichment with/without covered veranda

1. Turkeys for meat production and breeder turkeys are motivated to use a complex enriched environment with/without covered veranda.

2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of a complex enriched environment with/without covered veranda are Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation.
3. The appropriate age of the turkeys at first access to a covered veranda is 5 weeks, if easy transitions between the covered veranda and indoor area are ensured, and the weather conditions (temperature, wind, humidity, etc.) allow.
4. Research addressing the use and effects of a complex enriched environment with/without a covered veranda on turkey welfare is limited.

Complex enriched environment with outdoor range

1. Turkeys for meat production and breeder turkeys are motivated to use a complex enriched environment with an outdoor range.
2. The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of a complex enriched environment with an outdoor range are Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation.
3. The above-mentioned welfare consequences are experienced less by turkeys housed in a complex enriched environment with an outdoor range compared to turkeys housed without (certainty: 90%–100%).
4. The appropriate age of turkeys in commercial flocks when first accessing an outdoor range is 6–9 weeks, depending on the weather conditions (temperature, wind, humidity, etc.).
5. Research addressing the use and effects of a complex enriched environment with an outdoor range on turkey welfare is limited.

4.3 | Conclusions on space allowance

1. The relevant welfare consequences resulting from the hazard 'insufficient space allowance' (resulting in the hazard 'too high stocking density') are Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour and Inability to perform exploratory or foraging behaviour.
2. The following welfare consequences can indirectly be exacerbated by the hazard 'insufficient space allowance': Heat stress, Soft tissue lesions and integument damage, Gastroenteric disorders, Respiratory disorders and Locomotory disorders (including lameness).
3. The six classes of behaviour (stationary behaviours, dynamic behaviours, other comfort behaviours, wing flapping, dust-bathing and strutting (only for toms)) included in the behavioural space model are associated with the following welfare consequences caused by 'insufficient space allowance': Restriction of movement, Resting problems, Group stress, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Soft tissue lesions and integument damage and Locomotory disorders (including lameness).
4. The elicited average inter-individual distance on farm was obtained using morphological measurements for all six classes of behaviour resulting in 31.8 cm (90% certainty range: 17.2–60.8 cm) for turkey hens and 42.3 cm (90% certainty range: 23.8–69.3 cm) for turkey toms.
5. The minimum space allowance required to enable turkeys to perform stationary behaviours, dynamic behaviours, other comfort behaviours, wing flapping, dustbathing and strutting (only for toms) without restriction, while also preventing or mitigating the welfare consequences resulting from the hazard 'insufficient space allowance', differs between sexes and target body weights (see Table 8). The minimum space required for hens ranges from 0.49 m² per hen (90% certainty range: 0.31–0.93 m²/hen) at 7 kg target body weight to 0.61 m² per hen (90% certainty range: 0.42–1.11 m²/hen) at 16 kg target body weight, while for toms it ranges from 0.74 m² per tom (90% certainty range: 0.48–1.24 m²/tom) at 16 kg target body weight and 0.82 m² per tom (90% certainty range: 0.54–1.34 m²/tom) at 25 kg and more target body weight. These values assume that all other environmental and management factors are as recommended in this scientific opinion.

4.4 | Conclusions on concentration of ammonia

1. The relevant welfare consequences resulting from the hazard 'too high ammonia concentration' are Respiratory disorders and Eye disorders.
2. The EFSA experts are 66%–100% certain that the welfare consequences associated with the hazard 'too high ammonia concentration' *are prevented*, if the average 24-h ammonia concentration at bird head height is less than 10 ppm.
3. The EFSA experts are 66%–100% certain that the welfare consequences associated with the hazard 'too high ammonia concentration' *are present*, if the average 24-h ammonia concentration at bird head height is more than 25 ppm.
4. More research is needed to assess possible welfare consequences associated with ammonia concentrations between 10 and 25 ppm.

5. High ammonia concentration in a turkey barn is due to several factors including inadequate ventilation, high stocking density and water leakage.
6. Preventive measures to reduce ammonia emission include feed adjustments to minimise excess crude protein and balance levels of calcium, phosphorus, sodium and chloride.
7. A proper ventilation adjusted to the size and characteristics of the barn, climatic conditions, age of the turkeys and stocking density is a preventive and mitigation measure that helps to reduce ammonia concentration in turkey barns.
8. Continuous monitoring of litter quality and addition of new bedding (replenishment with the same or different bedding material) allow effective moisture absorption and reduce ammonia levels.

4.5 | Conclusions on concentration of carbon dioxide

1. The relevant welfare consequence resulting from the hazard 'too high CO₂ concentration' is Respiratory disorders.
2. The EFSA experts are 66%–100% certain that the welfare consequence associated with the hazard 'too high CO₂ concentration' is absent, if the average 24-h CO₂ concentration at bird head height is less than 2000 ppm.
3. The EFSA experts are 66%–100% certain that the welfare consequence associated with the hazard 'too high CO₂ concentration' is present, if the average 24-h CO₂ concentration at bird head height is more than 4000 ppm.
4. More research is needed to assess possible welfare consequences associated with CO₂ concentrations between 2000 and 4000 ppm.
5. High CO₂ concentration in a turkey barn is due to several factors including inappropriate heating system, inadequate ventilation, high stocking density and unbalanced diet composition.
6. A proper ventilation adjusted to the size and characteristics of the barn, climatic conditions, age of the turkeys and stocking density is a preventive and corrective measure helping to keep CO₂ concentration adequate in turkey barns.

4.6 | Conclusions on effective environmental temperature

1. The relevant welfare consequences resulting from the hazard 'inappropriate effective environmental temperature' are Cold stress and Heat stress. The effective environmental temperature is inappropriate when the turkey is outside of the thermal comfort zone for its age and genotype, which is assessed by the ABMs associated with Heat stress and Cold stress.
2. Cold stress in poults is prevented by pre-heating (some days before placement of poults) and heating of the barn (once poults are placed) and preventing draughts.
3. To prevent turkeys from experiencing Cold and/or Heat stress, effective environmental temperature control is also necessary after their first week of age.
4. Ventilation and heating are the main factors influencing effective environmental temperature inside the barn.
5. Tunnel ventilation, pad-cooling, fogging and reduced stocking density are the main measures to prevent and mitigate Heat stress inside the barn.
6. The EFSA experts are 66%–100% certain that the use of elevated structures prevents and mitigates Heat stress.

4.7 | Conclusions on group size

1. Evidence on the impact of commercial-scale group sizes on turkey welfare is not available and evidence is limited on smaller group sizes.
2. The relevant welfare consequence potentially resulting from the hazard 'too large group size' is Group stress.
3. The larger the group size the relatively more effort is needed by the personnel to conduct proper inspection of the flock and identify the occurrence of any welfare consequence.
4. Once flocks are established, environmental modifications to prevent and mitigate Group stress include enriching the environment with visual barriers, elevated structures, pecking and foraging materials, as well as adjusting lighting levels and ensuring sufficient access to feed and water.

4.8 | Conclusions on nest conditions

1. The relevant welfare consequence resulting from the hazard inadequate nest conditions is Inability to perform pre-laying and nesting (maternal) behaviour, which can lead to Group stress and Soft tissue lesions and integument damage.
2. Under commercial conditions, the hazards for these welfare consequences are 'lack of or insufficient nest box provision', 'improper dimensions and design of nest boxes', 'malfunction of the trap/push-off mechanism', 'lack of or insufficient or inappropriate nesting material' and 'too high light intensity'.
3. Turkeys prefer loose nesting materials such as peat, sand and wood shavings (certainty: 90%–100%).

4. There is lack of research on the impact of nest conditions including the number of hens per nest, design and functioning (light intensity, entrance, nesting material) and/or nest size (dimensions) on turkey hen welfare.
5. The relevant welfare consequence resulting from the hazard 'too high light intensity' in the barn above the nests during the early laying period is inability to express pre-laying and nesting (maternal) behaviour, as indicated by a higher prevalence of floor eggs.
6. There is no evidence supporting the current use of light intensities between 100 and 140 lux in the barn above nests at the peak of the production period.
7. The number of hens per nest reported in practice and in industry guidelines is between 4 and 7. Within this range, the lower the number, the lower the risk of Inability to express pre-laying and nesting (maternal) behaviour, Group stress and Soft tissue lesions and integument damage (certainty: 66%–100%). There is a knowledge gap regarding welfare consequences of less than four hens per nest.
8. Continuous monitoring of nest trap and push-off mechanism function ensures early detection of malfunction and timely intervention when necessary.

4.9 | Conclusions on flock thinning and removal of hens

1. Evidence on the impact of flock thinning or removal of hens on the welfare of turkeys is limited.
2. Stocking density (kg/m^2) peaks at multiple time points when flock thinning is practised: shortly before (each) flock thinning and again before slaughter of the remaining turkeys. In the case of removal of hens, stocking density of toms peaks shortly before hens are removed and again before the toms are sent to slaughter.
3. The practices of flock thinning and removal of hens therefore increase the risk for the hazard 'insufficient space allowance' (due to 'too high stocking density') and the associated welfare consequences, such as Restriction of movement.
4. Several steps in the practices of flock thinning and removal of hens affect the welfare of the turkeys that remain on the farm. The process of catching and moving birds can lead to Handling stress, Sensory overstimulation and Gastroenteric disorders, while feed/water withdrawal can lead to Prolonged hunger and Prolonged thirst, and changes in group size/social disruptions can lead to Group stress.
5. Compared to the removal of hens, flock thinning results in a higher prevalence and magnitude (duration $\times$ severity) of welfare consequences for birds while in the flock.

4.10 | Conclusions on mutilations

Beak trimming

1. The most common type of mutilation performed on turkeys in the EU is beak trimming (toms and hens for meat production and breeding).
2. Beak trimming of turkeys is conducted to reduce the prevalence and severity of the welfare consequences Soft tissue lesions and integument damage and Group stress caused by injurious pecking.
3. As currently practised, beak trimming causes acute pain (certainty: 90%–100%); EFSA experts are 66%–100% certain that it also leads to chronic pain.
4. The relevant welfare consequences resulting from the practice of trimming the beak are Handling stress and Soft tissue lesions and integument damage, which may lead to Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Prolonged thirst and Prolonged hunger.
5. Beak trimming effectively reduces the damage caused by injurious pecking (certainty: 90%–100%).
6. However, Soft tissue lesions and integument damage inflicted by beak-intact turkeys performing injurious pecking is prevented if appropriate housing conditions and management practices are in place (certainty: 66%–100%).
7. Provision of environmental enrichment, strategic genetic selection, appropriate light conditions, adequate space allowance and natural blunting or smoothing of the beak are preventive and mitigation measures of the damage caused by injurious pecking of beak-intact turkeys.
8. There is a lack of knowledge on how effective locally applied anaesthesia is to prevent pain due to the Soft tissue lesions and integument damage caused by beak trimming.
9. The welfare consequences are less severe when infrared beak trimming is applied compared to the other beak trimming methods.
10. The severity of the Soft and nervous tissue damage caused by beak trimming increases with the age of the turkey at the time of the procedure (certainty: 66%–100%).

Desnooding

1. Desnooding is a painful procedure performed in toms to prevent trauma, haemorrhage and bacterial infection caused by injurious pecking directed at the snoods later in the life of the birds.
2. Desnooding of toms kept for breeding and for meat production is practised in a few EU Member States.

3. The relevant welfare consequences resulting from desnooding are Soft tissue lesions and integument damage and Handling stress. Desnooding also impairs thermoregulation and exacerbates the likelihood of Heat stress under high effective environmental temperatures (certainty: 66%–100%).
4. In snood-intact turkeys, Soft tissue lesions and integument damage due to injuries pecking at the snood is prevented if appropriate housing and management practices are in place (certainty: 66%–100%).
5. Provision of environmental enrichment, genetic selection, appropriate lighting conditions, adequate space allowance and natural blunting or smoothing of the beak are measures that prevent injurious pecking at the snood.
6. There is lack of knowledge on how effective locally applied anaesthesia are to prevent pain due to the Soft tissue lesions and integument damage caused by desnooding.

Toe trimming

1. Toe trimming (mainly in hens kept for meat production) is practised in a few EU Member States.
2. Toe trimming of turkeys for meat production and turkey breeders is conducted to prevent the welfare consequence Soft tissue lesions and integument damage inflicted on conspecifics by the turkeys' nails. In the case of turkey breeders, toe trimming is also carried out to prevent injuries to handlers during semen collection and artificial insemination.
3. Toe trimming causes acute pain and can cause chronic pain, e.g. when bacteria infect toe wounds or when a neuroma forms.
4. The relevant welfare consequences resulting from toe trimming are Soft tissue lesions and integument damage and Locomotory disorders (including lameness), which may lead to other welfare consequences such as Inability to perform exploratory and foraging behaviour, Prolonged thirst and Prolonged hunger.
5. When kept under conventional housing conditions, intact toes increase the risk of Soft tissue lesions and integument damage (i.e. ABM: scratches) in turkey hens (certainty: 66%–100%), but not in toms (certainty: 66%–100%).
6. It is 66%–100% certain that damage caused by intact toes of hens can be prevented if appropriate housing conditions and management practices are in place.
7. It is 90%–100% certain that the damage caused by intact toes of toms can be avoided if appropriate housing conditions and management practices are in place.
8. Provision of environmental enrichment, appropriate lighting conditions, adequate space allowance and the use of devices that blunt, smoothen or shorten the claws can prevent damage caused by toe-intact turkeys.
9. There is lack of knowledge on how effective locally applied anaesthesia are in preventing pain due to the Soft tissue lesions and integument damage caused by toe trimming.

4.11 | Conclusions on lighting conditions

1. The main hazards identified are 'too low light intensity', 'inappropriate photoperiods and lighting programmes', 'inappropriate light spectrum composition' and 'inappropriate flickering'. 'Too high light intensity' is a hazard when the hazards 'inadequate enrichment' and 'insufficient space allowance' are present in the turkey barn.
2. The relevant welfare consequences resulting from these hazards are Group stress, Soft tissue lesions and integument damage, Resting problems, Eye disorders, Locomotory disorders (including lameness) and Sensory under- and/or overstimulation.
3. There is lack of turkey-specific light measurement tools reflecting light intensity as perceived by the turkeys.
4. There is no research investigating the impact of light intensities above 10 lux on injurious pecking in commercial flocks of turkeys.
5. Preventive and mitigation measures include lighting systems and programmes that provide appropriate light intensity, photoperiod and spectral composition (including UV-A), while ensuring gradual transitions and flickering at a sufficiently high frequency for the turkeys not to perceive it.

4.12 | Conclusions on artificial insemination

1. Artificial insemination involves the collection of semen from toms and insemination of hens. The procedures are practised in commercial turkey production, particularly for heavy- and medium-weight genotypes that cannot mate naturally due to physical constraints and/or the risk of injuries as a side-effect of selection for production traits.
2. The artificial insemination procedures include several welfare hazards, mainly due to the repeated handling of toms and hens, physical restraint, repeated collection of semen in toms and repeated invasive insemination of hens. The relevant welfare consequences resulting from these hazards are Soft tissue lesions and integument damage, Reproductive disorders and Handling stress. A secondary welfare consequence of Handling stress is Bone lesions.
3. The relevant welfare consequences resulting from feed withdrawal of toms before semen collection longer than 6 h are Prolonged hunger (certainty: 66%–100%) and post-withdrawal Group stress (certainty: 66%–100%).
4. Insemination before sexual maturity causes oviduct damage and results in the welfare consequence Reproductive disorders in hens.

5. Artificial insemination cannot be avoided under current farming conditions, but the welfare consequences can be mitigated by reducing the risk of exposing the turkeys to the associated hazards. Personnel training is an essential mitigation measure to ensure semen collection and insemination procedures are carried out without causing any harm to the birds.
6. Handling stress during semen collection and insemination is also influenced by environmental factors, such as lighting programmes.

4.13 | Conclusions on feed restriction of turkey breeders

1. There is no knowledge on the welfare consequences of the currently applied qualitative feed restriction in turkey breeders, and limited knowledge of the currently applied quantitative feed restriction.
2. The relevant welfare consequence resulting from the quantitative feed restriction applied to breeder toms during the semen production period are Prolonged hunger (certainty: > 50%–100%) and Group stress (certainty: > 50%–100%).

4.14 | Conclusions on hatchery conditions

1. The relevant welfare consequences resulting from the hazards 'excessive egg storage duration', 'lack of a diurnal light/dark cycle', 'excessive noise', 'inappropriate handling and equipment' and 'excessive holding period' are Umbilical disorders, Locomotory disorders (including lameness), Eye disorders, Sensory under- and/or overstimulation, Resting problems, Restriction of movement, Prolonged hunger, Prolonged thirst and Handling stress.
2. Newly-hatched poults subject to feed and water deprivation for longer than 48 h (from hatching to access to feed and water at placement on farm) experience Prolonged hunger and Prolonged thirst (certainty: 66%–100%).
3. Provision of a diurnal light/dark schedule of approximately 12 h/12 h and use of low-noise fans in the incubators and hatchers prevent Sensory overstimulation.
4. The hazard 'excessive noise' is present if the sound pressure level is 90 dB or above (certainty: > 50%–100%).
5. There is limited research on the welfare consequences associated with sound pressure levels below 90 dB. It is therefore unknown whether sound pressure levels below 90 dB have a negative impact on welfare.
6. A preventive measure for Umbilical disorders, Eye disorders and Locomotory disorders (including lameness) is to keep the egg storage duration at a minimum. However, available knowledge is insufficient for determining a maximum egg storage duration that prevents the associated welfare consequences.
7. Immediate cessation of sudden loud noises is a mitigation measure for Sensory overstimulation.
8. Preventive and mitigation measures for Prolonged hunger and Prolonged thirst include the provision of water and feed, or liquid feed (such as hydrogels), respectively, as well as light in the hatcher and/or transport boxes and ensuring earlier access to feed and water by shortening the hatching window, minimising the number of hatchery procedures done and reducing waiting time before transport.
9. Mitigation measures specific for Prolonged thirst include reducing the risk of overheating by increasing the space allowance in transport boxes, enhancing ventilation and lowering the environmental temperature to match the poults' thermal comfort zone.
10. Mitigation measures for Handling stress include reducing conveyor belt speed and drop heights, avoiding sudden changes in belt speed (e.g. when moving from belt to belt), ensuring considerate handling of poults, training staff in proper handling and supervision and maintaining well-designed belts with regular upkeep and continuous monitoring.
11. A mitigation measure for Resting problems is dimming the light intensity during the waiting time, as it will encourage synchronous resting.

4.15 | Conclusions on welfare aspects of genetic selection and breeding strategies

1. Evidence on the impact of genetic selection and breeding strategies on the welfare of turkeys is limited.
2. Breeding impacts turkey welfare indirectly through (unforeseen) genetic correlations between traits or through direct selection for welfare traits.
3. The relevant welfare consequences associated with genetic selection and breeding strategies are Locomotory disorders (including lameness), Restriction of movement, Soft tissue lesions and integument damage, Inability to perform comfort behaviour, Inability to perform exploratory or foraging behaviour, Prolonged hunger, Prolonged thirst, Respiratory disorders and Gastroenteric disorders.
4. The relevant welfare consequence associated with the data collection of traits for phenotyping or genotyping is Handling stress.
5. Breeding for welfare traits currently focuses on aspects of liveability/disease resistance, leg health/walking ability and reduced proneness to perform injurious pecking behaviour. However, the definitions of the underlying genetic traits, how they are used in the breeding programme and phenotypic trends following selection, are not always known, making it difficult to assess the impact on the welfare consequences.

6. Breeding for welfare traits alone will only mitigate, and not prevent, the welfare consequences listed in conclusion 3 due to the influence of non-genetic factors (e.g. environment, housing, management).
7. Genetic selection for the traits of increased body weight, growth rate and breast meat yield with a high weight in the selection index is associated with the hazard 'over-emphasising increased productivity'.
8. Increased body weight, growth rate and breast meat yield have unfavourable genetic correlations with traits related to walking ability/leg health, footpad dermatitis, muscle myopathies, liveability/longevity, immune response/disease susceptibility, cardiovascular or respiratory system (e.g. lung volume), pendulous crop and drinking behaviour.
9. Simultaneous breeding for multiple traits may partly help overcome the consequences of unfavourable genetic correlations between production and welfare traits and may reduce the risk of welfare consequences.

4.16 | Conclusions on ABMs collected in slaughterhouses to assess the level of welfare of turkeys on farm

1. The ABMs that can be collected and measured at slaughterhouses do not cover all the relevant welfare consequences present on-farm.
2. Total mortality on farm, plumage damage, carcass condemnation, wounds, breast blisters and FPD are the most promising slaughterhouse ABMs to monitor the on-farm welfare of turkeys.
3. The birds that experience the welfare consequences most severely will not be sent to the slaughterhouse. Consequently, the ABMs collected at the slaughterhouse may underestimate the prevalence and the severity of the ABMs on farm.
4. There is a high variability in the methodology used at the slaughterhouse for assessing each ABM. Uniform and standardised scoring systems and protocols to monitor the welfare of turkeys across different slaughterhouses/regions/EU Member States are generally missing.
5. There is generally a lack of knowledge of the reliability and validation status of automated methods to assess ABMs used at slaughterhouses.
6. Methods to assess FPD automatically in turkeys are used routinely at slaughter in some EU Member States. However, there is no standardised method across the EU Member States for measuring FPD in turkeys.
7. The Technology Readiness Level (TRL) of automated monitoring of the ABMs at slaughterhouse differs between the proposed ABMs. FPD is the most advanced followed by breast blisters and wounds.
8. Training and calibration of assessors and automatic methods are important for assessing the ABMs reliably.

5 | RECOMMENDATIONS

5.1 | Recommendations on the type and condition of the litter

1. A layer of bedding should be distributed on the pre-heated floor before the arrival of the poults. It should cover the entire floor without being too deep to avoid impairing the exploration capacities of the poults, and with sufficient heating of the floor itself (i.e. the floor should be at the same temperature as the air and the bedding).
2. It is recommended to maintain dry litter conditions (below the threshold of 35–40% humidity) to provide thermal insulation for turkeys and prevent Cold stress, which is especially a risk for young poults that are more sensitive. This is particularly important in colder climates or during winter months when temperature control in barns can be more challenging.
3. Providing turkeys with a dry and friable litter is recommended for preventing Resting problems, Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Soft tissues and integument damage and Group stress leading to severe feather pecking and aggression.
4. Use of chopped straw (or straw pellets) followed by wood shavings is recommended to prevent litter from becoming too humid. Unchopped straw should be avoided.
5. Ventilation should always be adjusted to the size and characteristics of the barn, the climatic conditions and the age, number and health conditions of turkeys.
6. At least daily (visual) monitoring of litter quality and application of the necessary actions to keep litter dry are recommended.
7. Litter turning and partial replacement of wet litter with new bedding are recommended to improve litter quality and mitigate welfare consequences for the turkeys.

5.2 | Recommendations on the type and availability of enrichment

Elevated structures for perching

1. Provision of access to elevated structures is recommended for turkeys for meat production and breeder turkeys from 1 week of age, preferably in the form of platforms.

2. It is recommended to provide ramps to the elevated structures for all turkeys to have easy access. Research on the maximum slope for optimal use is needed.
3. It is recommended to adapt the space allowance on the elevated structures according to the category of turkeys housed, considering their sex and target weight.
4. For breeder hens (body weight 12 kg), it is recommended to provide 0.12 m² of platform per bird or alternatively 0.35 m of planks per bird during the production period.
5. More research is needed for calculating the needed space allowance on the elevated structures for turkey categories other than breeder hens. The influencing factors to take into consideration are animal categories (meat or breeder turkeys), sex and target weight.
6. Until further evidence is available, the EFSA experts recommend a space allowance on elevated structures for hens and toms kept for meat production, immature breeder hens and toms (rearing period) and mature breeder toms (production period) similar to that recommended for breeder hens.

Foraging and exploratory material

1. The EFSA experts recommend that all categories of turkey are provided throughout life with edible exploration and foraging materials, such as straw, corn silage, wheat grain in feeders and pecking blocks.
2. It is recommended that the exploratory and foraging materials are available continuously during the photophase to the turkeys.
3. It is recommended that the exploratory and foraging materials are available at multiple locations in the barn to ensure that all turkeys within a flock have access.
4. More research is needed to determine the quantity of the foraging and exploratory materials needed for them to be accessible for all turkeys within a flock of commercial size and for the materials to be effective in preventing or mitigating the welfare consequences Inability to perform exploratory or foraging behaviour, Group stress, Soft tissue lesions and integument damage and Locomotory disorders (including lameness).

Visual barriers

1. It is recommended that all categories of turkey have access to visual barriers (such as tunnels and panels) in the barn throughout their life.
2. It is recommended that the visual barriers are available at multiple locations on the floor of the barn for all turkeys within a flock to have unhindered access.
3. More research is needed to determine the quantity and design of visual barriers needed to prevent Group stress and Soft tissue lesions and integument damage.

Dust baths

1. The EFSA experts recommend that all categories of turkeys are provided with substrate suitable for dustbathing or with specific dust baths throughout life.
2. In addition to the litter, it is recommended that dust baths or substrate are available and suitable for dustbathing at multiple locations in the barn for all turkeys within a flock to have unhindered access.
3. More research is needed to determine the quantity of dustbaths needed to prevent Inability to perform comfort behaviour.

Complex enrichment with/without covered veranda

1. The EFSA experts recommend that turkeys are housed in a complex enriched environment, including enrichment targeting different motivations such as elevated structures, exploratory and foraging material, visual barriers, substrate suitable for dustbathing or specific dust baths. Preferably, this is combined with access to a covered veranda (minimum 20% additional space, in addition to useable area).
2. It is recommended that first access to a covered veranda is when turkeys are 5 weeks-old if the weather conditions (temperature, wind, humidity, etc.) allow. The housing design should guarantee easy transitions between the covered veranda and the indoor area.
3. More research is needed to determine the characteristics of a complex enriched environment with/without a covered veranda to prevent or mitigate the welfare consequences Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation in turkeys.

Complex enriched environment with outdoor range

1. EFSA experts recommend turkeys to be housed in a complex enriched environment, including enrichment targeting different motivations such as elevated structures, exploratory and foraging material, visual barriers, substrate suitable for dustbathing or specific dust baths. Preferably, this is combined with access during daytime to an outdoor range.
2. It is recommended that first access to an outdoor range is when the turkeys are 6–9 weeks of age, depending on weather conditions.
3. More research is needed to determine the characteristics of an outdoor range needed to prevent or mitigate the welfare consequences. Inability to perform exploratory or foraging behaviour, inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation in turkeys.

5.3 | Recommendations on space allowance

1. To prevent or mitigate the associated welfare consequences, the minimum space allowance resulting from the behavioural space model, should be adapted to the sex and the target slaughter weight of the turkeys:
 - a. for hens of 7 kg target body weight, the minimal space allowance is 0.49 m² per hen (90% certainty range: 0.31–0.93 m²/hen). This is equal to a stocking density of 14.4 kg/m² (90% certainty range: 7.5–22.3 kg/m²), meaning 2.06 hens per m² (90% certainty range: 1.07–3.19 hens/m²).
 - b. for hens of 12 kg target body weight, the minimum space allowance is 0.57 m² per hen (90% certainty range: 0.38–1.04 m²/hen). This is equal to a stocking density of 21.2 kg/m² (90% certainty range: 11.5–31.6 kg/m²), meaning 1.76 hens per m² (90% certainty range: 0.96–2.63 hens/m²).
 - c. for hens of 16 kg target body weight, the minimum space allowance is 0.61 m² per hen (90% certainty range: 0.42–1.11 m²/hen). This is equal to a stocking density of 26.2 kg/m² (90% certainty range: 14.5–38.5 kg/m²), meaning 1.64 hens per m² (90% certainty range: 0.91–2.41 hens/m²).
 - d. for toms of 16 kg target body weight, the minimum space allowance is 0.74 m² per tom (90% certainty range: 0.48–1.24 m²/tom). This is equal to a stocking density of 21.4 kg/m² (90% certainty range: 12.9–33.3 kg/m²), meaning 1.34 toms per m² (90% certainty range: 0.80–2.08 toms/m²).
 - e. for toms of 20 kg target body weight, the minimum space allowance is 0.78 m² per tom (90% certainty range: 0.51–1.04 m²/tom). This is equal to a stocking density of 25.6 kg/m² (90% certainty range: 15.5–39.5 kg/m²), meaning 1.28 toms per m² (90% certainty range: 0.78–1.97 toms/m²).
 - f. for toms of 25 kg or more target body weight, the minimum space allowance is 0.82 m² per tom (90% certainty range: 0.54–1.34 m²/tom). This is equal to a stocking density of 30.4 kg/m² (90% certainty range: 18.7–46.5 kg/m²), meaning 1.22 toms per m² (90% certainty range: 0.75–1.86 toms/m²).
2. To decrease the uncertainty of the behavioural space model outputs, it is recommended to obtain, share and analyse more data on the inter-individual distances preferred by turkeys when performing different behaviours.

5.4 | Recommendations on concentration of ammonia

1. The EFSA experts recommend that ammonia concentration is kept below 10 ppm at bird head height on average over 24 h.
2. To prevent the occurrence of the hazard 'too high ammonia concentration', it is recommended to continuously monitor ammonia (measured at bird head height) and litter quality to apply quick mitigation measures, when needed, including adjusting the ventilation to the size and characteristics of the barn, the climatic conditions and the age, quantity and health conditions of the turkeys, while also guaranteeing set temperature and humidity levels.
3. The use of watering systems designed to minimise leakage, and the continuous control of their functionality, is highly recommended to limit ammonia emissions in turkey barns.

5.5 | Recommendations on concentration of carbon dioxide

1. The EFSA experts recommend that the concentration of carbon dioxide is kept below 2000 ppm at bird head height on average over 24 h.
2. To prevent the occurrence of the hazard 'too high carbon dioxide concentration', it is recommended to continuously monitor carbon dioxide (measured at bird head height) and regularly maintain and inspect heating systems to apply quick mitigation measures, when needed, including adjusting the ventilation to the size and characteristics of the barn, the climatic conditions and the age, quantity and health conditions of the turkeys, while also guaranteeing set temperature and humidity levels.

5.6 | Recommendations on effective environmental temperature

1. It is recommended to maintain the effective environmental temperature at a level where the turkeys show no indications of Heat Stress or Cold stress, assessed by using the associated ABMs.
2. Ventilation and heating should be regularly controlled in order to ensure the appropriate effective environmental temperature inside the barn.
3. To prevent poults from experiencing Cold stress due to the hazard 'too low effective environmental temperature', it is recommended that draughts are avoided, and that the barn is pre-heated before placement of the poults so that the floor, the litter and the air reach the required effective environmental temperature.
4. To prevent and mitigate the turkeys experiencing Heat stress due to the hazard 'too high effective environmental temperature', it is recommended to use tunnel ventilation, pad-cooling, elevated structures and/or fogging.

5.7 | Recommendations on group size

1. Conducting further studies is recommended to directly compare turkey welfare across a range of group sizes, including those representative of commercial operations to fill critical knowledge gaps on the group size and its linkage with Group stress.
2. Strategies such as improved resource distribution, enrichment (e.g. visual barriers, elevated structures, foraging and pecking material) and minimising social disruptions to promote welfare are recommended to mitigate Group stress in large flocks.

5.8 | Recommendations on nest conditions

1. It is recommended to regularly monitor the nesting behaviour of breeder turkey hens, especially at the start of the laying phase, for early detection of Inability to express pre-laying and nesting (maternal) behaviour and Group stress, and to implement timely interventions.
2. Continuous monitoring and maintenance of the nest trap and push-off mechanisms (if applicable) are recommended to ensure they open and close properly as well as to early detect malfunctioning and timely intervene when necessary.
3. It is recommended to use appropriate nesting material such as peat, sand or wood shavings, which meets hens' needs and enables hens to express pre-laying behaviour, and to regularly top it up.
4. It is recommended to avoid high light intensity in the barn above the nests and consider nest darkening during the early laying period to reduce the welfare consequence Inability to express pre-laying and nesting (maternal) behaviour.
5. A maximum of four hens per nest is recommended. More research is needed on the impact of the hen-to-nest ratio on the associated welfare consequences, especially when there are less than four hens per nest.
6. More research is recommended to determine the appropriate nest dimensions, light intensity above the nests and nesting material from an animal welfare perspective.
7. More research is needed to determine the light intensity threshold in the barn above the nests that affects the welfare consequence Inability to express pre-laying and nesting (maternal) behaviour.

5.9 | Recommendations on flock thinning and removal of hens

1. Based on the welfare consequences experienced by the remaining birds associated with the practice of flock thinning, that cannot be prevented or substantially mitigated (e.g. Group stress), it is recommended to discontinue this practice.
2. Based on the existing knowledge and on the welfare consequences experienced by the remaining toms associated with the practice of removal of hens, it is recommended to avoid the practice of removal of hens unless a series of preventive and mitigation measures is applied:
 - a. The stocking density (measured in kg/m²) should be kept at or below the maximum stocking density recommended (see recommendation 1 on Space allowance) at any given timepoint, i.e. both before and after removal of hens.
 - b. Catchers should receive training to handle turkeys and minimise Handling stress and be made aware of their impact on the remaining toms in the barn, even if these birds are not moved.
 - c. Measures to limit excessive lighting, temperature or air movement in the barn are recommended to avoid Sensory overstimulation during catching.
 - d. Good biosecurity practices during the removal of hens need to be followed in terms of personnel and equipment to avoid the spread of pathogens that can lead to health-related welfare consequences, e.g. Gastroenteric disorders.
 - e. To prevent Prolonged hunger and Prolonged thirst, it is recommended that feeder/drinker lines in separated hen and tom areas in the same house can be operated independently such that toms will not be deprived of feed/water when hens are caught.

- f. If prevention of feed/water withdrawal is not possible, it is recommended that the total duration of feed/water withdrawal is as short as possible (for water withdrawal from the start of removing hens, and for feed withdrawal below 6 h) to avoid that toms experience Prolonged hunger, Prolonged thirst and subsequent Group stress.
 - g. In case toms are split across different houses after removal of hens, it is recommended to avoid social disruptions and apply strategies such as adequate resource distribution and/or enrichment (e.g. visual barriers, elevated structures, foraging and pecking material) to mitigate Group stress.
3. More research is recommended on the comparison of the welfare of turkeys in flocks where removal of hens is not applied with those where it is applied. When removal of hens is applied, the welfare of all turkeys should be considered (i.e. before and after removal of hens) as well as the duration and magnitude of any potentially beneficial/negative effects on turkey welfare.

5.10 | Recommendations on mutilations

Beak trimming

1. It is recommended to phase out the practice of beak trimming due to the associated welfare consequences.
2. Strategies to prevent injurious pecking should be implemented before beak trimming is phased out and sustained after the phasing out. These strategies include:
 - a. provision of environmental enrichment, genetic selection, appropriate light conditions, adequate space allowance and natural blunting or smoothing of the beak (see Section 3.2.10.4.1 for details);
 - b. collection of knowledge on good practices from the EU Member States where beak trimming has been omitted for decades.
3. Strategies to mitigate Soft tissue lesions and integument damage due to injurious pecking should be applied, including:
 - a. monitoring to identify injured birds and moving them into a sick pen with the space allowance recommended in this scientific opinion;
 - b. gradually reduce the light intensity applied during the photoperiod;
 - c. provision of additional environmental enrichment.
4. Until beak trimming is phased out, it is recommended to:
 - a. Perform the procedure at as early an age as possible (e.g. at the hatchery).
 - b. Apply infrared beak trimming technology among the methods currently available.
 - c. Develop practical and effective methods of pain relief during and after beak trimming is performed.

Desnooding

1. It is recommended to phase out the practice of desnooding due to the associated welfare consequences.
2. Strategies to prevent Soft tissue lesions and integument damage of the snood should be implemented and optimised before desnooding is phased out and continued after the practice has been phased out. These include:
 - a. provision of environmental enrichment, genetic selection, appropriate light conditions, adequate space allowance and natural blunting or smoothing of the beak (see Section 3.2.10.2 for details);
 - b. collection of knowledge on good practices from the EU Member States where desnooding has been omitted for decades.
3. Until desnooding is phased out, it is recommended to develop practical and effective methods of pain relief during and after desnooding is performed.

Toe trimming

1. It is recommended to phase out the practice of toe trimming due to the associated welfare consequences.
2. Strategies to prevent damage caused by intact toes should be implemented and optimised before toe trimming is phased out. These include:
 - a. provision of environmental enrichment, appropriate lighting conditions, adequate space allowance and use of devices that blunt, smoothen or shorten the claws (see Section 3.2.10.4.3 for details);
 - b. collection of knowledge on good practices from the EU Member States where toe trimming has been omitted for decades.

3. Until toe trimming is phased out, it is recommended to develop practical and effective methods of pain relief during and after toe trimming is performed.

5.11 | Recommendations on lighting conditions

1. Turkeys should be provided with a minimum light intensity of 10 lux during the photophase at bird-eye level, in accordance with the Council of Europe (2001)²⁰ recommendation. Temporary reductions down to 5 lux may be used only when necessary to control injurious pecking and should not be routine practice.
2. A stable light–dark cycle with age-adjusted dark phases should be maintained to support circadian rhythms and allow resting behaviour. Constant light should not be used.
3. Lighting programmes characterised by step-up and step-down schedules should be gradual and predictable to prevent the welfare consequences Soft tissue lesions and integument damage, Group stress, Resting problems and Sensory under- and/or overstimulation.
4. Exposure to daylight or artificial lighting that includes UV-A wavelengths should be provided to align with turkeys' visual system and reduce the risk of Group stress and Soft tissue lesions and integument damage. Lighting equipment should be selected to avoid perceptible flicker for turkeys.
5. Continuous monitoring of relevant animal-based measures, such as injurious pecking, plumage condition, resting behaviour and indicators of stress, is essential to assess the adequacy of the lighting conditions in place.
6. Research is needed on the spectral sensitivity of turkeys for a turkey-specific light measurement tool to be developed and used for evaluating light intensity as perceived by the turkeys.
7. Research is needed to investigate how light intensities above 10 lux can be applied without increased risk of injurious pecking in commercial flocks of turkeys.

5.12 | Recommendations on artificial insemination

1. Artificial insemination of turkeys should whenever possible be carried out by the same person to promote habituation and minimise the associated welfare consequences.
2. Staff involved in semen collection and insemination should receive training on appropriate bird handling, correct manipulation techniques and animal welfare indicators.
3. Continuous monitoring of the flock for behavioural or production anomalies should be done for early detection and mitigation of welfare consequences associated with artificial insemination.
4. The first insemination of the turkey hens should occur only after sexual maturity when hens show signs of readiness (e.g. squatting behaviour) to prevent hens experiencing Reproductive disorders.
5. Feed withdrawal of the toms before semen collection should not be practised. If it is allowed, feed withdrawal should be as short as possible to avoid Prolonged hunger and Group stress and not exceed 6 h.

5.13 | Recommendations on feed restriction of turkey breeders

1. It is recommended to avoid the practice of quantitative feed restriction in toms.
2. Research is needed to investigate (a) the impact of qualitative and quantitative feed restriction on welfare consequences in turkeys and (b) management strategies to avoid quantitative feed restriction in turkeys (e.g. dilution of feed).

5.14 | Recommendations on hatchery conditions

1. It is recommended to keep egg storage duration as short as possible to prevent Umbilical disorders, Eye disorders and Locomotory disorders (including lameness).
2. More research is needed to determine a maximum egg storage duration preventing the associated welfare consequences.
3. It is recommended to apply a lighting programme consisting of 12 h/12 h (light/darkness) and avoid sound pressure levels above 90 dB during incubation of the eggs to prevent Sensory under- and overstimulation affecting the poults later.
4. More research is needed to assess the impact of sound pressure levels below 90 dB on Sensory under- and/or overstimulation.
5. It is recommended to keep the time between hatching and placement on farm as short as possible and no more than 48 h post-hatch to prevent Prolonged hunger and Prolonged thirst.
6. It is recommended to provide water and feed or liquid feed (such as hydrogels), as well as light in the hatcher and/or transport boxes to prevent or mitigate Prolonged hunger and Prolonged thirst.

²⁰<https://www.coe.int/en/web/cdcj/2001-rec-turkeys>.

7. It is recommended to keep handling time as short as possible to reduce Handling stress.
8. It is recommended to avoid changes in speed on conveyor belts greater than 0.4 m/s, drop heights above 280 mm and speeds of 27 m/min or more to prevent Handling stress.
9. More research is needed to assess the impact of changes in speed on conveyor belt lower than 0.4 m/s, drop heights below 280 mm and speeds below 27 m/min on Handling stress.
10. It is recommended to train staff in proper handling and surveillance of the system to prevent Handling stress.
11. It is recommended to use both hands to support the full body of the poults during handling to prevent Handling stress.

5.15 | Recommendations on welfare aspects of genetic selection and breeding strategies

1. The hazard 'over-emphasising increased productivity' should be limited by increasing the number of welfare traits and their relative weight, while reducing the relative weight of the production traits in the breeding goal.
2. Specifically, there should be more emphasis on leg health traits and less emphasis on the production traits in the breeding goals.
3. Genetic correlations and causal relationships between traits should be considered in the breeding goal to mitigate the welfare consequences of unfavourable relationships between traits.
4. Data supporting claims of changes in welfare outcomes at pedigree to commercial level should be made available to evaluate changes over time.
5. More research is needed to compare the welfare consequences of the selection for different final turkey target weights (light, medium and heavy lines) and average daily weight gain.
6. Genetic selection and breeding strategies to improve welfare of turkeys should always be considered in combination with improvements in housing and management.
7. Handling stress in turkey breeders should be minimised by recording multiple traits simultaneously as opposed to collecting single traits on multiple occasions, when possible and by using properly trained staff.
8. The use of technologies to automatically record individual behavioural traits should be considered to improve the integration of these traits in the breeding goal.

5.16 | Recommendations on ABMs collected on slaughterhouses to assess the level of welfare of turkeys on farm

1. It is recommended to implement monitoring of footpad dermatitis, total mortality on farm, plumage damage, wounds, breast blisters and carcass condemnation in turkeys at slaughter to identify flocks of turkeys experiencing different welfare consequences on farm, allowing targeted inspection and establishment of preventive measures for the next flocks.
2. For the assessment of ABMs at slaughter, it is recommended that automated technologies are validated before being implemented.
3. It is recommended that the protocols for manual assessment of ABMs at slaughter are standardised and validated.
4. Calculation of the cumulative daily mortality rate and cumulative daily culled rate is recommended for each week of the production cycle together with the rates at the time of slaughter to provide information on the pattern of mortality in the flock. These data are measured at the farm and transmitted with the flock at slaughter.
5. Harmonised assessment methods and scoring systems are advised to be developed and implemented for the identified ABMs. In addition, the reliability of the methods used to measure these ABMs needs to be examined.

ABBREVIATIONS

ABM	animal based measures
AI	artificial insemination
B.U.T.	Big United Turkeys
CIWF	Compassion in World Farming
CDF	cumulative distribution function
CO ₂	carbon dioxide
CT	computed tomography
EFFAB	European Forum of Farm Animal Breeders
EKE	expert knowledge elicitation
FPD	footpad dermatitis
HTL	Heterophil–lymphocyte ratio
MS	Member State
NCPs	Network of the National Contact Points
NGO	Non-governmental organisation
NH ₃	ammonia
RSPCA	Royal Society for the Protection of Cruelty to Animals

SD	standard deviation
THI	temperature-humidity index
ToR	Term of Reference
TRL	technology readiness level
VDP	Verband Deutscher Putenerzeuger
WC	Welfare consequence
WoS	Web of Science

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

Protocol

TABLE A.1 Problem formulation using APRIO approach (agent-pathway-receptor-intervention-output) for the assessment questions related to Terms of References (TOR) 2, 3 and 4 for a scientific opinion on the welfare of turkeys on farm.

Number as appeared in the mandate	Mandate element	Agent	Pathway	Receptor	Intervention	Output	Lower or higher order sub-questions
TOR 2, 3 and 4	TOR 2 a-f, 3 and 4. Welfare assessment of housing conditions, practices, breeding and hatching of turkeys	Factors/practices 1. Litter 2. Enrichment 3. Covered veranda 4. Outdoor space 5. Space allowance 6. Concentration of ammonia 7. Concentration of CO ₂ 8. Temperature 9. Light conditions 10. Group size 11. Separation of males and females 12. Final weight 13. Average daily weight gain 14. The practice of thinning 15. Feed and water provision 16. Age of onset of breeding 17. Nest conditions 18. Artificial insemination 19. Hatchery conditions 20. Beak trimming 21. Other mutilations (e.g. detoeing, desnooding.) 22. Breeding and genetic traits	The theoretical relationships between the 22 factors listed that lead to the welfare consequence(s)	1. Turkey poults 2. Turkey toms kept for meat production 2. Turkey hens kept for meat production 3. Turkey breeder hens 4. Turkey breeder toms	The measures applied to the factors with the objective to prevent or mitigate the welfare consequences	Assessing the effect of the interventions/practices on the welfare consequences measured by ABMs (e.g. footpad dermatitis, plumage damage, etc.)	1. a. What are (and briefly describe) the current housing conditions and practices for turkeys in the EU and particularly in top EU turkey country producers? b. What are the most prevalent factors and practices listed in the mandate in each housing system? 2. What are the relevant welfare consequences affected by each of the agents (i.e. factors/practices)? 3. What are the ABMs (definition, interpretation) for assessing each of the welfare consequence? 4. What are the interventions applied to the factors/practices, to prevent or mitigate the welfare consequences, and what is their effect on the welfare consequences experienced by the animals? Some examples are: increase or reduce space allowance; early age of first artificial insemination of turkey hens, feed and water restriction of turkey breeders, the age of animals and provision of pain relief and anaesthesia when conducting beak trimming, toe trimming, de snooding, the provision of appropriate nests and the broodiness of turkey hens.

TABLE A.2 The approach for conducting the assessment related to TORs 2, 3 and 4.

	Sub-question	Evidence needed	Data collection	Assessment method to be used	Output
TOR 2 Assess the risk to welfare of turkeys kept for meat production, breeders and poults (in hatcheries and on-farm)	1 a. What are and briefly describe the current housing conditions and practices for turkeys in the EU and particularly in top EU turkey country producers? 1 b. What are the most prevalent factors in each housing system and practice?	Description of the housing conditions and practices that include the factors included in the TOR 2 for turkeys in the EU	For TOR 2a – 2f (focused on housing conditions: litter, outdoor, space, etc. and practices: thinning, separation of sexes, mutilations, temperature, genetic strategies, etc.). The Working Group experts will identify and briefly describe the housing systems and husbandry practices, using expert knowledge and citing literature where appropriate. This will allow the WG experts to conduct the welfare risk assessment on this topic. A description of housing systems will also be delivered via TOR 1 (Article 31: TOR1 a technical report describing housing systems and husbandry practices). Data collection methods include survey/interviews, review reports, scientific literature and other grey literature (including reputable websites) and peer reviewed literature if necessary. When the draft technical report from TOR 1 is available, more detail or practices not previously identified, relating to current housing practices may be incorporated into the Scientific Opinion. A public call for evidence and stakeholder consultation are planned to provide relevant information on housing conditions and husbandry practices as this was one of the eight topics of interest of the call for evidence.	- Literature review in peer reviewed articles, grey literature, industry reports - Ad hoc stakeholders' consultation and the Member States consultation (planned for mutilations practised in turkeys) - All complemented by expert opinion via group discussion.	Description of the housing systems and practices for keeping turkeys for meat production, breeders and hatcheries with a specific focus on top producers of turkeys in the EU (Germany, Poland, France, Italy, Spain). Given the list of husbandry systems, a map of the different factors/hazards according present in these systems (prevalent or not) will be provided.
TOR 3 Identify the relevant welfare consequences of the housing systems and the risk factors and practices described in TOR 1 and 2, by using ABMs for the assessment of these welfare consequences.	2. What are the relevant welfare consequences affected by each of the agents (i.e. factors/practices)?	Identification of the relevant (i.e. most important) welfare consequences and their relationship with the agents (i.e. factors/practices) listed in the mandate.	Same data collection activities as above to collect data on the relevant welfare consequences and their relationship with the agents.	- Literature review of peer reviewed articles, grey literature, industry reports - Ad hoc stakeholders' consultation - All complemented by expert opinion via group discussion.	A list of the relevant welfare consequences for each of the listed factors in the defined practices or housing systems is produced. To define the welfare consequences in accordance to the guidance (EFSA AHAW Panel, 2022a) and highlight species specificities for turkeys.

(Continues)

TABLE A.2 (Continued)

	Sub-question	Evidence needed	Data collection	Assessment method to be used	Output
	1. What are the ABMs for assessing each of the relevant Welfare Consequences?	Evidence that the ABMs allow assessing the relevant welfare consequences previously identified. To include definition and interpretation of the ABMs.	Same activities as for TOR 2 to collect data on the ABMs useful for assessing the relevant welfare consequences.	- Literature review of peer reviewed articles, grey literature, industry reports - Ad hoc stakeholders' consultation - All complemented by expert opinion via group discussion.	Identification and description of the ABMs useful for assessing the relevant welfare consequences identified in TOR 2.
TOR 4. Provide qualitative and, where applicable, quantitative recommendations to prevent or mitigate the welfare consequences on farm identified in TOR 3.	2. What are the measures applied on the factors/ practices to prevent or mitigate the welfare consequences, and what is their effect on the welfare consequences experienced by the turkeys (e.g. minimum space allowance to prevent the welfare consequence restriction of movement)?	A demonstration or description of the effect of the measures on the relevant welfare consequences (previously selected) as monitored by the ABMs (previously identified).	Same activities as for TOR 2 and 2 to collect data on the ABMs useful for assessing the relevant welfare consequences.	- Literature review of peer reviewed articles, grey literature, industry reports - Ad hoc stakeholders and the EU Member States consultation - All complemented by expert opinion via group discussion.	Identify and describe the preventive and mitigation measures for the welfare consequences. The effect of the measures will be described using narrative text, figures and tables as appropriate.

TABLE A.3 The problem formulation related to the TOR 5.

Number as appeared in the mandate	Mandate element	Agent	Pathway	Receptor	Intervention	Output	Lower or higher order sub-questions
TOR 5	The assessment of animal-based measures (ABMs) collected in slaughterhouses to monitor the level of welfare on farm for turkeys.	N/A	The theoretical relationship between the ABMs assessed at slaughter and the welfare consequences experienced by the turkey birds in the farms	Turkeys that reach slaughter weight and are sent to slaughter	N/A	A list of ABMs to propose for collection at an abattoir/ slaughterhouse, indicative of turkeys on farm welfare.	What are the ABMs assessed at an abattoir/ slaughterhouse, indicative of the level of animal welfare on farm for turkeys?

TABLE A.4 The approach for conducting the assessment related to TOR 5.

	Sub-question	Evidence needed	Data collection	Assessment method to be used	Output
TOR 5. Assess and define suitable animal-based indicators collected at the slaughterhouse to monitor the level of welfare of turkeys on farm.	Identify and describe the ABMs that can be collected at the slaughterhouse to monitor the level of welfare of turkeys on farm.	Identify the turkey bird category to assess for this TOR. Identification of the ABMs that are currently monitored at the EU slaughterhouse; provide information on their feasibility, relevance and the link to the welfare consequences experienced on turkey farms.	Collect information on which categories of turkey birds reach the slaughterhouse (e.g. turkeys kept for meat production, turkey breeders) A proposed list of ABMs (<i>ante-mortem</i> and <i>post-mortem</i>) and their descriptions have already been identified by EFSA experts based on the existing literature (EFSA AHAW Panel, 2023b; Welfare Quality®, 2009). To gather information on the use of the ABMs in the proposed list, the ABMs were discussed by the EFSA scientific NCPs Network (EFSA, 2023). • Consultation with the EU Member States during EFSA network meetings and with stakeholders (call for evidence) on which ABMs are monitored at the slaughterhouse. • Data on ABMs from Literature search also produced through the FPA • Expert knowledge	Experts will be consulted on the categories of turkeys that reach the slaughterhouse. From the ABMs already identified (see data collection) a semi-quantitative consensus exercise based on expert opinion of the working group and literature review will be carried out to identify those ABMs that could best represent the level of welfare of turkeys on farm by the contractor. The exercise will consist of two steps: (i) Screening of ABMs; (ii) Selection of ABMs. Screening is carried out per each ABM considering relevance to animal welfare, relationship with on-farm welfare, existing data or literature, feasibility for large scale collection. Selection will be based on the welfare consequences associated with the ABM, if the ABM is already used at slaughter, priority given from EFSA network and technology readiness.	Identification and description of ABMs that can be monitored at the slaughterhouse to assess the welfare of turkeys on farm.

A.1. | Uncertainty analysis

Sources of uncertainty

The sources of uncertainty relevant to this Scientific Opinion (TOR 2, 3, 4 and 5) generally relate to consider external and internal validity. External validity is limited because of variability between different genotypes of turkeys being used amongst studies. This means that the results from one particular study may not be generalisable to other genotype. Internal validity may be limited because some studies are small, cross-sectional, may not have fully controlled for potential confounders and the measures used are rarely standardised. In this case, there is a low degree of certainty that causal relationships proposed are true effects. Additional research studies using robust study designs to establish causal relationships would be needed to provide unequivocal evidence of the impact of housing practices on the welfare of turkeys (see [Table A.5](#)).

TABLE A.5 Sources of uncertainty.

Topic	Sources of uncertainty	Impact on the assessment
Identification & description of the common housing systems	Regional differences. Variations between production systems (e.g. breeds, housing) Length of the production cycle Regional differences and diverse husbandry practices across regions.	Possible limited generalisability of the description of housing systems and practices applied in turkeys. Some of this uncertainty was reduced due to information on housing systems and applied practices in different EU Member states provided by stakeholders through the EFSA Public call for evidence (December 7 2023–31 January 2024) EFSA, 2024
Assessment of welfare consequences (occurrence, severity, duration), ABMs and preventive and corrective measures.	Very limited data on prevalence of welfare consequences. Scarcity of published evidence, which required extrapolation from other poultry categories/ species such as broilers, laying hens and duck, geese and quail in some cases. The selection of the relevant welfare consequences was done through group discussion and could vary slightly if the composition of the working group was different. Literature search characteristics (e.g. search performed mainly in the English language; not all synonyms may have been used in search terms; only one main database used (Web of Science – core collection) although the search was complemented with manual searches of the literature; grey literature not extensively searched)	The number of relevant welfare consequences, ABMs may have been underestimated or overestimated.

The uncertainty in the assessment performed for this Scientific Opinion was analysed following the procedure detailed in the EFSA guidance on uncertainty analysis in scientific assessments (EFSA Scientific Committee, [2018](#)) and EFSA guidance for the development of animal welfare mandates in the context of the Farm to Fork strategy (EFSA AHAW Panel, [2022a](#), [2022b](#)) with some modifications.

The outcome of the assessment of this request (TORs 2, 3, 4 and 5) will be the identification and description of current practices of keeping turkeys, the identification of relevant welfare consequences and the related ABMs for each hazard or practice listed in the mandate and for each relevant animal category, and the identification of measures to prevent or mitigate these welfare consequences. Conclusions and recommendations will be made based on these elements.

The uncertainty related to the identification and description of current practices and husbandry systems, and to the selection of the welfare consequences and their related ABMs will be limited to the identification and description of the sources of uncertainty, and the potential impact of the uncertainty on the assessment.

The uncertainty analysis relating to conclusions is produced by the elicitation of expert opinion: Working Group experts are asked to provide their individual judgement on the certainty for each conclusion according to three pre-defined agreed certainty ranges (See [Table A.6](#)), which are derived from the approximate probability scale from the guidance on uncertainty (EFSA, [2019](#)).

TABLE A.6 Three ranges that will be used to express agreed (consensus) certainty around conclusions (adapted from EFSA, [2019](#)).

Certainty range			
Quantitative assessment	> 50%–100%	66%–100%	90%–100%
Qualitative translation	More likely than not	From likely to almost certain	From very likely to almost certain

Subsequent to the experts' individual categorisation of certainty for the conclusions, a group discussion is held during which each expert explains the rationale behind their judgement and a group consensus on which range better reflects the overall certainty will be sought. A qualitative translation of the outcome of the uncertainty assessment will also be derived (e.g. 'more likely than not' for a certainty range of > 50%–100%) (see [Table A.6](#)).

APPENDIX B

Literature searches

Literature search-type and condition of the litter

- No restriction of languages;
- Web of Science All Databases;
- Between 2004 and 2024
- *exclusion criteria*: diet;
- *Inclusion*: slaughter (in the case of relation to type of litter and litter condition on the farm and assessment of on-farm welfare).

Search string for turkeys:

((TS=(Turkeys OR "Meleagris gallopavo" OR "turkey poult*" OR "poults" OR "turkey hen*" OR "turkey tom*" OR "turkey breeder*") AND TS=(*farm* OR "housing" OR husbandry OR cage)) AND TS=("animal welfare" OR "wellbeing" OR "well-being" OR stress* OR pain* OR behav* OR protection OR mov* OR locomot* OR "resting" OR lame* OR "foot pad dermatitis" OR "foot-pad dermatitis" OR "dustbathing" OR explor* OR forag* OR "wing and leg stretch*" OR "wing stretch*" OR "leg stretch*") AND TS=(litter OR bed* OR bedding OR "litter condition" OR "litter treatment" OR substrate) NOT TS=(diet))

Results: 206 articles; Results after screening for relevance: 62.

Literature search – type and availability of enrichment

(((((TS=("Turkeys" OR "Meleagris gallopavo" OR "turkey poult*" OR "poults" OR "turkey hen*" OR "turkey tom*" OR "turkey breeder*") AND TS=(*farm* OR "housing" OR husbandry OR cage)) AND TS=("welfare" OR wellbeing OR stress* OR pain* OR behav* OR explore* OR comfort OR protection OR preening OR dustbathing)) AND TS=(enrich* OR perch* OR platform* OR plank* OR tunnel* OR string* OR "plastic bottle*" OR veranda* OR outdoor OR straw* OR substrate* OR "free range" OR "free-range")))) – 221 – All Databases (webofscience.com)

Link TO WEB OF SCIENCE SEARCH <https://www.webofscience.com/wos/woscc/summary/c2b153d8-9a53-4466-8e87-6886e4c4470c-d1a80025/relevance/1>

Results: 60 items found from Web of Science Core Collection; 25 relevant articles;

Literature search – space allowance

Date of the search 11 March 2024;

- restriction to English;
- Web of Science All Databases;
- no specific time limit applied
- *exclusion criteria*: transport, nest and nest condition, other poultry else than turkeys;
- *Inclusion criteria*: slaughter (in the case of relation to space allowance in the farm and assessment of on-farm welfare).

Search string:

(((((TS=("Turkeys" OR "Meleagris gallopavo" OR "turkey poult*" OR "poults" OR "turkey hen*" OR "turkey tom*" OR "turkey breeder*") AND TS=(*farm*)) AND TS=("welfare" OR wellbeing OR stress* OR pain* OR behav* OR mov* OR "locomotory disorders" OR "resting problems" OR "lameness" OR "foot pad dermatitis" OR "foot-pad dermatitis" OR "Restriction of movement") AND TS=("stock* density" OR "stock*" OR "floor*" OR "space allowance" OR "space" OR "area")))))

Results: 142 references; Results after screening for relevance:15;

In addition 7 documents deemed relevant from public call (PC) for evidence; EFSA, 2024 PC 0741, Länsi-Kalkkuna Ltd., 3 space allowance in different husbandry system, EFSA, 2024, PC 0741 Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung 3, space allowance in different husbandry systems), EFSA, 2024 PC 0741 3, space allowance in different husbandry systems RSPCA UK, EFSA, 2024, PC 0741, Four Paws, 8- welfare assessment in turkey, Beaulac et al., 2019, Erasmus, 2017, Dalton et al., 2013 sent in a list by Compassion in world farming brussels CIWF in EFSA, 2024, PC 0741.

Literature search – hatchery conditions

Exact date of the search: 24th June 2025

Defined time of search period: 1954–2025;

Search string: ("egg storage" AND (turkey OR poult)) OR ("hatchery AND (turkey OR poult) OR ("hatching equipment" AND (turkey OR poult)) OR ("hatch sorting" AND (turkey OR poult)) OR ("handling" AND (turkey OR poult)) OR ("belt speed" AND (turkey OR poult)) OR ((drops OR ramps OR "drop height") AND (turkey OR poult)) OR ("vaccination" AND (turkey OR poult)) OR ("embryo euthanasia" AND (turkey OR poult)) OR "poult euthanasia" OR ("boxing density" AND (turkey OR poult)).

Database	Total number of hits	Number of articles deemed of interest	Number of articles used in the review	Number of repeated articles
Usask ^a	25,128	41	21	N/A
Cambridge journals	174	2	0	0
Google Scholar	4000	41	21	41
Oxford Academic	0			
Web of Science	1281	41	21	41
Sage Journals	12	1	1	1

^a USAK stands for the University of Saskatchewan Library System that includes 508 Databases.

Additional articles were accumulated throughout the data extraction process through following citations of cited papers (snowballing). The EFSA AHAW Panel (2023a, 2023b, 2023c) scientific opinion concerning the welfare of broilers was also included.

Literature search – concentration of CO₂

A broad literature search was conducted to identify studies describing the effects of CO₂ concentrations on turkey welfare. The search was performed using web of science database and restricted to records published between 1980 and 30/09/2024 with the aim to include as much as possible of publications related to the topic. Language restrictions aimed at identifying only publications with an English abstract and full text.

The query search was as follow: (((TS=(Turkeys OR "Meleagris gallopavo") AND TS=("carbon dioxide" OR "CO2" OR "air quality" OR "air pollu*" OR "pollution") AND TS=(*farm* OR "housing" OR husbandry OR cage OR ventilation OR "indoor systems")) AND TS=("welfare" OR stress* OR "health" OR pain* OR comfort* OR behav* OR protection)))).

The link allowing the access to the search is the following: <https://www.webofscience.com/wos/woscc/summary/8040761f-fc3d-4f58-8c76-7823a2cc50cc-010d499d33/relevance/1> (Date: 30/09/2024).

The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant metadata (e.g. title, authors, abstract). Titles and abstracts were screened for relevance and duplicates were removed. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper. The used criteria for including a publication in the results was that it gives details about CO₂ concentration in turkey houses and its possible effects on bird welfare.

Results of the search: 127; relevant articles after screening for relevance: 13; Reasons for exclusion: Related to turkey country (54), not related to CO₂ effects of turkeys (17), related to ventilation for human beings (12), related to other species or other topics (30), duplicates 1;

Literature search – concentration of ammonia

A broad literature search was conducted to identify studies describing the effects of ammonia concentrations on turkey welfare.

The search was performed using web of science database and restricted to records published between 1980 and 30/09/2024 with the aim to include as much as possible of publications related to the topic. Language restrictions aimed at identifying only publications with an English abstract and full text.

The query search was as follow: (((TS=(Turkeys OR "Meleagris gallopavo") AND TS=("Ammonia" OR "NH3" OR "Air quality" OR "Air pollu*" OR "pollution") AND TS=(*farm* OR "housing" OR husbandry OR cage OR ventilation OR "indoor systems")) AND TS=("welfare" OR "health" OR stress* OR pain* OR comfort* OR behav* OR protection)))).

The link allowing the access to the search is the following: <https://www.webofscience.com/wos/woscc/summary/d9faaa2a-50b9-46f4-ae6a-3773b6d6c423-010d38ae71/relevance/1> (Date: 30/09/2024).

The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant metadata (e.g. title, authors, abstract). Titles and abstracts were screened for relevance and duplicates were removed. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper. The used criteria for including a publication in the results was that it gives details about ammonia concentration in turkey houses and its possible effects on bird welfare.

Results of the search: 121; Relevant articles after screening: 20; Total excluded per reason: Related to Turkey countr (53), not related to ammonia effects on turkeys (3), related to ventilation for human beings (8), related to other species or other topics (36), duplicates (1).

Literature search – effective environmental temperature

A broad literature search was conducted to identify studies describing the effects of temperature on turkey welfare. The search was performed using web of science database and restricted to records published between 1980 and 17/10/2024 with the aim to include as much as possible of publications related to the topic. Language restrictions aimed at identifying only publications with an English abstract and full text.

The query search was as follow: (((TS=(Turkeys OR "Meleagris gallopavo") AND TS=("heat stress" OR hyperthermia OR "cold stress" OR hypothermia OR "thermal stress" OR "thermal comfort") AND TS=(*farm* OR "housing" OR husbandry OR cage OR "covered veranda" OR "free range" OR "outdoor range")) AND TS=("welfare" OR stress* OR pain* OR comfort* OR behav* OR protection))))).

The link allowing the access to the search is the following: <https://www.webofscience.com/wos/woscc/summary/130e6d41-8000-4885-9ea8-4c2e1ecb5abd-0113011d4c/relevance/1> (Date: 17/10/2024).

The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant meta-data (e.g. title, authors, abstract). Titles and abstracts were screened for relevance and duplicates were removed. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper. The used criteria for including a publication in the results was that it gives details about temperature in turkey houses and its possible effects on bird welfare.

The above search procedure led to the inclusion of a total of seven articles from web of science database. The text below summarises the search strategy leading to the abovementioned results.

Results: 40, results after screening: 7; Reason for exclusion of the articles: related to Turkey country (10), not related to temperature effects of turkeys (8), related to other species (e.g. laying hens, broilers) or other topics (e.g. water management) (15).

Literature search – feed restriction

A broad literature search was conducted using the search string below:

Exact search dates: 26th June 2025

Defined time of search period: 1942–2025

Search String: ("feed restriction" AND "turkey breeder") OR ("hunger" AND "turkey breeder") OR ("genetic selection" AND "turkey breeder") OR ((growth OR weight) AND "turkey breeder") OR ("obesity" AND "turkey breeder") OR ("feeding regime" AND "turkey breeder") OR ("feeding strategies" AND "turkey breeder") OR ("reproductive paradox" AND "turkey breeder") OR ("quantitative feed restriction" AND "turkey breeder") OR ((stress AND feed) AND "turkey breeder") OR ("quantitative restriction" AND "turkey breeder") OR ("qualitative restriction" AND "turkey breeder") OR ((corticosterone AND feed) AND "turkey breeder") OR ("overweight" AND "turkey breeder") OR ("fear" AND "turkey breeder") OR ("welfare" AND "turkey breeder") OR ((physiology AND "feed restriction") AND "turkey breeder").

Google Scholar Search String: "turkey breeder" ("feed restriction" OR hunger OR "genetic selection" OR growth OR weight OR obesity OR "feeding regime" OR "feeding strategies" OR "reproductive paradox" OR "quantitative feed restriction" OR stress OR "quantitative restriction" OR "qualitative restriction" OR corticosterone OR overweight OR fear OR welfare OR physiology).

Database	Total number of hits	Number of articles used in the review	Number of duplicate
Usask (includes 508 journals)	128	38	N/A
Cambridge journals (> 420 journals)	7128	0	0
Google Scholar	3060	23	21
Oxford Academic	0	–	–
Web of Science	100	10	11
Sage Journals	17	0	0

General reason for exclusion of articles were: Review article, other species (quail, broiler breeders, broilers, rabbits, pigs, goats, laying hens, guinea pigs, sheep, rats, fish, horses, cows, humans, bats, penguins, sea urchins, deer, dogs, cats, foxes, etc.), not relevant to feed restriction, country of Turkey.

In addition management guidelines Aviagen, 2025b and Hendrix 2023 did not appear on any searches, but were used in the assessment.

Literature search – lighting conditions

Exact date of the search 26th June 2025

Defined time of search period: 1961–2024

Search String: ("Daylength" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Photoperiod" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Pattern of light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Light duration" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Wavelength" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Light colour" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Intensity" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Lux" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Clux" AND ("poultry" OR "turkeys" OR "turkey")) OR ("gallilux" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Foot candles" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Light source" AND ("poultry" OR "turkeys" OR "turkey")) OR ("LED" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Natural Light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Fluorescent light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Welfare" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Well-being" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Natural living" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Management" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Production" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Health" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Mortality" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Behaviour" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Injurious pecking" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Enrichment" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Ocular health" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Ultraviolet light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Melatonin" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Serotonin" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Illumination" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Corticosterone" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Flicker frequency" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Aggression" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Footpad lesions" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Incandescent light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Compact fluorescent light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Light emitting diode light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("High pressure sodium light" AND ("poultry" OR "turkeys" OR "turkey")) OR ("Metal halide lamps" AND ("poultry" OR "turkeys" OR "turkey")).

Information from the breeding companies (page 7) was not found in the literature reviews, but author's knowledge of their works resulted in inclusion of that information.

Database	Total number of hits	Number of articles deemed of interest	Number of repeated articles
Usask (includes 508 journals)	538,580	120	0
Cambridge journals	1517	4	4

General reason for exclusion (relevant articles marked in review reference list): Aspects within the country of Turkey, turkey papers simply mentioning lighting programmes, other poultry species (leghorn, broiler, geese), review papers in which originals were already included (WPSJ in particular), disease, turkey transport, stunning of turkeys, turkey diseases, turkey nutrition, other animals (rabbits, sheep, goats, dogs, dolphins, cattle, pigs), environment, sexual maturity, turkey meat processing, marketing and consumption patterns of poultry products (turkey), poultry nutrition, pest management, poultry euthanasia methodologies, general poultry lighting (not specific to turkeys), climate change.

Literature search – Flock thinning and removal of hens

A broad literature search was conducted to identify studies describing the effects of flock thinning or removal of hens on turkey welfare. The search was performed using web of science database and restricted to records published between 1980 and 2024 with the aim to include as much as possible of publications related to the topic. Language restrictions aimed at identifying only publications with an English abstract and full text.

The initial search query was as follow: ((TS=(poultry OR broiler* OR turkeys OR "Meleagris gallopavo")) AND TS=("thinning" OR "partial depopulation" OR "removal of hens")).

Search was done 25-4-2025.

The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant metadata (e.g. title, authors, abstract). Titles and abstracts were screened for relevance and duplicates were removed. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper. The used criteria for

including a publication in the results was that it gives details about flock thinning and removal of hens from turkey houses and the possible effects on bird welfare.

In addition, a snowball sample method was applied and information was found on EFSA BIOHAZ panel, 2020, EFSA AHAW panel, 2022a, EFSA AHAW Panel, 2023a.

Results: 275 articles; Results after screening = 6 articles.

Literature search – impact of genetic selection on welfare

Date of the search: 2nd March 2025 on Web of Science Core collection and on Google Scholar.

Without time restriction, with articles with title and abstract in English.

The search string included the following search strings on genetics, liveability, robustness and disease resistance, cardiovascular capacity, muscular problems, trait aggressive behaviours, trait leg health, Broodiness and nesting behaviour, reproductive traits and productive traits.

Genetics

TS=(“meleagris gallopavo”) AND (welfare OR well-being OR wellbeing OR “animal welfare” OR behaviour) AND (trait* OR gene* OR “genetic selection” OR heritab* OR inherit*) AND NOT (turkish OR children OR hospital OR turkiye).

Liveability, robustness and disease resistance

TS=(turkeys OR “meleagris gallopavo”) AND (liveability OR (disease AND resistance) OR (disease AND tolerance) OR robust* OR viability OR “quality of life” OR “immune competence” OR “resistance to stress” OR “stress-resistant”) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Cardiovascular capacity

TS=(turkeys OR “meleagris gallopavo”) AND ((cardiac AND disease) OR (cardiovascular AND disease) OR (cardiac AND function) OR (cardiovascular AND capacity) OR (cardiovascular AND function) OR (cardiac AND capacity) OR ascites OR “pulmonary hypertension” OR “perirenal haemorrhage” OR “perirenal hemorrhage” OR “spontaneous aortic rupture” OR lathyrism OR “round heart disease” OR “spontaneous aortic rupture”) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Muscular problems

TS=(turkeys OR “meleagris gallopavo”) AND (myopathy* OR (myopathic* AND (disease OR condition)) OR “pectoral myopathy” OR (pale AND soft AND exudative AND meat) OR “focal myopat*” OR “white striping” OR “wood* breast” OR “spaghetti meat”) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Trait aggressive behaviours

TS=(turkeys OR “meleagris gallopavo”) AND (“aggressive behaviour*” OR aggress* OR aggressive pecking OR (injurious AND peck*) OR (head AND peck*) OR (injurious AND feather AND peck*) OR (cannibalism OR peck*) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Trait leg health

TS=(turkeys OR “meleagris gallopavo”) AND (“footpad dermatitis” OR “foot-pad dermatitis” OR pododermatitis OR pododermatitis OR (footpad AND lesions) OR (foot-pad AND lesions) OR (foot-pad AND lesions) OR “hock burn” OR “hock-burn” OR (skeletal AND abnormalit*) OR (leg AND abnormalit*) OR (“angular deformit*” OR “tibial dyschondroplasia OR (gait AND score) OR (walk* AND ability* OR (footpad AND shape) OR (foot-pad AND shape)) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Broodiness and nesting behaviour

TS=(turkey OR “meleagris gallopavo”) AND (broodiness OR brood* (nesting AND behavi*)) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Reproductive traits

TS=(turkey OR “meleagris gallopavo”) AND (reproduct* OR hatchability OR fertility OR (egg AND (number OR weight OR quality*))) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Productive traits

TS=(turkey OR “meleagris gallopavo”) AND (product* AND (body AND weight) OR (carcass AND yield) OR (breast AND (yield OR weight)) OR “feed conversion ratio” OR “average daily gain” OR “residual feed intake” OR “carcass quality” OR “meat quality”) AND (genetic OR inherited OR gene OR genes OR trait* OR “genetic selection” OR heritab*) AND NOT (turkish OR children OR hospital OR turkiye).

Results: 296; without duplicates 199; 166 relevant;

Reason to exclude: focus was on diet, focusing on phenotyping turkeys, focused on turkeys reared in Africa in conditions too different from those in Europe, not on turkeys.

Literature search – artificial insemination

The search was performed using Google Scholar on 18 June 2025 and restricted to records published between 1970 and 2024. Language restrictions aimed at identifying publications with an English abstract and full text. However, a search was also conducted for relevant publications in German with an English abstract. For the literature search, research gate (<https://www.researchgate.net>) and google scholar were used (<https://scholar.google.de>), as well as the online library of the University of Hanover and the websites of breeding companies. In addition, own existing literature sources were included.

Relevant publications were downloaded as PDFs. The used criteria for including a publication in the results was that it gives details regarding the search criteria listed above and its possible effects on turkey welfare.

The search terms used is below.

TS=(turkey*) AND (artificial insemination OR semen collection OR semen storage OR semen quality OR welfare OR breeding technologies OR artificial insemination interval OR environmental light).

The search procedures led to the inclusion of a total of 35 articles from research gate and google scholar database. Excluded articles: 11; 24 articles were kept as relevant for the assessment.

Literature search – Use of ABMs at slaughter to assess the welfare of turkeys on farm

For the description of the ABMs collected in slaughterhouses to monitor the level of welfare on farm for turkeys an extensive literature review was conducted on the 6th of August 2024, using the bibliographic database ‘Web of Science’ (all databases). Language restrictions aimed at identifying only publications with an English abstract and full texts of a language covered in the expertise of EFSA experts. The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant metadata (e.g. title, authors, abstract). Duplicates were removed. Titles and abstracts were screened for relevance. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper.

Literature search: Total mortality on farm

Date of the search : 6th of August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language=English).

Search string: (((TS=(Turkeys OR “Meleagris gallopavo”) AND TS=(“mortality rate*” OR “death rate” OR “total mortality” OR “cumulative mortality” OR Cull*) AND TS=(farm* OR barn* OR flock* OR “on-farm”) AND TS=(“welfare” OR “health” OR “protection”) NOT TS=(“transport”))).

Results: 43. Results after screening for relevance: 15.

Literature search: Carcass condemnations

Date of the search: 6th of August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language=English).

Search string: (((TS=(Turkeys OR “Meleagris gallopavo”) AND TS=(“carcass*” OR “carcase*” OR “viscera”) AND TS=(“condemnation*” OR “rejection*” OR “downgrad*” OR “trimm*” OR “condemned”) AND TS=(slaughter OR slaughterhouse* OR “abattoir*” OR “slaughter line” OR “slaughter factory” OR “slaughter plant”) AND TS=(“welfare” OR “health” OR “protection” OR “inspection” OR “meat”) NOT TS=(“econom*” OR “value”))).

Results: 17. Results after screening for relevance: 10.

Literature search: Wounds

Date of the search: 6th of August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language= English).

Search string: (((TS= (Turkeys OR "Meleagris gallopavo") AND TS= ("skin") AND TS= ("punctiform spot*" OR "scratch*" OR "Wound*" OR "bruise*" OR "damage" OR "rupture*" OR "injur*") AND TS= (slaughter OR slaughterhouse* OR "abattoir*" OR "slaughter line" OR "slaughter factory" OR "slaughter plant")))).

Results: 25. Results after screening for relevance: 4.

Literature search: Plumage damage

Date of the search : 6th of August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language= English).

Search string: (((TS= (Turkeys OR "Meleagris gallopavo") AND TS= ("feather damage" OR "plumage damage" OR "plumage loss" OR "plumage deterioration" OR "featherless*" OR "feather loss" OR "denuded area" OR "naked area" OR "naked skin" OR "nude area" OR "nude skin") AND TS= (slaughter OR slaughterhouse* OR "abattoir*" OR "slaughter line" OR "slaughter factory" OR "slaughter plant") AND TS= ("welfare" OR "health" OR "protection" OR "inspection" OR "meat")))).

Results: 4. Results after screening for relevance: 4.

Literature search: Breast blisters

Date of the search: 6th of August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language= English).

Search string: (((TS= (Turkeys OR "Meleagris gallopavo") AND TS= ("breast blister*" OR "swelling" OR "bursa paraesternalis" OR "hygroma" OR "pus" OR "bursitis sternalis") AND TS= (slaughter OR slaughterhouse* OR "abattoir*" OR "slaughter line" OR "slaughter factory" OR "slaughter plant") AND TS= ("welfare" OR "health" OR "protection" OR "inspection" OR "meat")))).

Results: 9. Results after screening for relevance: 4.

Literature search: Foot pad dermatitis

Date of the search: 7th August 2024. Web of Science (WoS core collection, Advanced search. timespan: 1980–2024. Language= English).

Search strings: (((TS= (Turkeys OR "Meleagris gallopavo") AND TS= ("footpad dermatitis" OR "foot-pad dermatitis" OR welfare) AND TS= (slaughter OR slaughterhouse OR "abattoir" OR "slaughter line" OR "slaughter factory" OR "slaughter plant") AND TS= ("welfare" OR "health" OR "protection" OR "inspection" OR "meat")))).

Total number of articles from web of science: 99; Number of selected articles: 19; Number of articles found in the references of the selected articles: 24; Results after screening for relevance: 43.

Literature search – mutilations

Date of the search: 8th of November 2024. Web of Science (WoS core collection, BCI, CABi, Medline Advanced search. timespan: 1980–2024. Language= English).

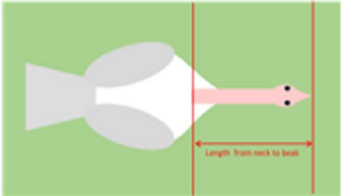
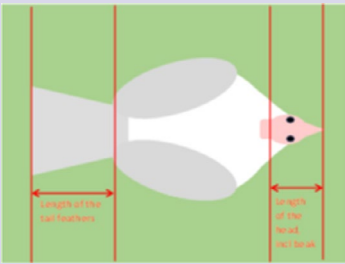
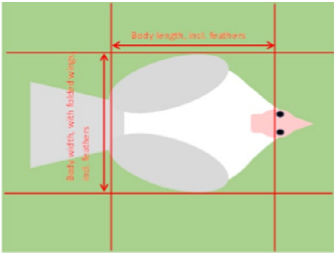
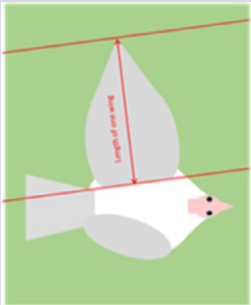
Search string: (((TS= (Turkeys OR "Meleagris gallopavo") AND TS= (*mutilations* OR "beak trimming" OR "beak treatment" OR "debeaking" OR "partial beak amputation" OR "claw remov*" OR "Toe trimming" OR "Toe remov*" OR "de-toeing" OR "toe-clipping" OR "de-snooding")) AND TS= ("animal welfare" OR stress* OR pain* OR comfort* OR behav* OR protection)))).

Results: 35; Results after screening for relevance: 28

APPENDIX C

EKE Behavioural space model

A – Schematic representation of morphological dimensions in turkeys.
Data on morphological dimensions of turkeys were collected from the EFSA's Working Group experts own network. Instructions were provided as below.

Schematic representation	Morphological dimensions and description
	Neck-to-beak length: the distance measured from the base of the neck where it attaches to the body to the tip of the beak when the neck is stretched fully
	Head-to-beak length: the distance measured from the base of the head to the tip of the beak Tail length: the distance measured from the base of the tail to the tip of the longest feather
	Body length: the distance measured of the body without the tail and neck Body width: width of the body with wings folded against the body
	Wing length: the distance measured of the wing from the base where it attaches to the body to the point of the wing farthest away from the body

B – EKE results on space for stationary behaviours in turkeys at 20 kg and summary of evidence used.

Overview of the results of the expert knowledge elicitation															
Parameter	Space (planimetric) occupied by the bird when performing stationary behaviours, e.g. standing, resting, sitting, feeding and drinking														
Stratification	Turkeys (hens/toms, all breeds) with a slaughter weight of 20 kg														
Question	What is the average space on the ground that the turkeys shortly before slaughter occupy with their bodies when performing stationary behaviour ?														
Unit	[cm ²]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	1400					1550		1650		1750					1850
EKE results	1400	1416	1437	1471	1508	1548	1585	1653	1717	1748	1781	1808	1830	1842	1851
Fitted distribution	BetaGeneral(1.5237, 1.2203, 1380, 1858)														

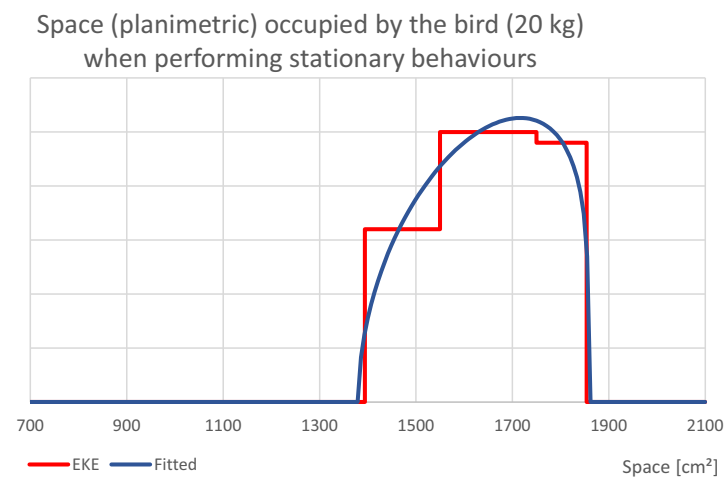


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

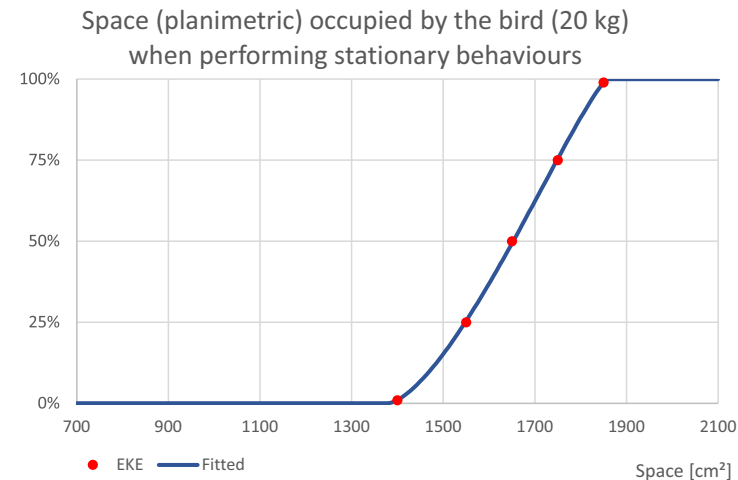


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Space (planimetric) occupied by the bird (7 kg)
when performing stationary behaviours

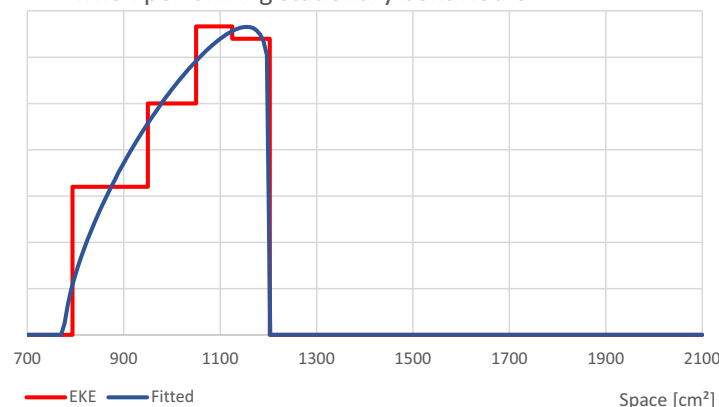


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Space (planimetric) occupied by the bird (7 kg)
when performing stationary behaviours

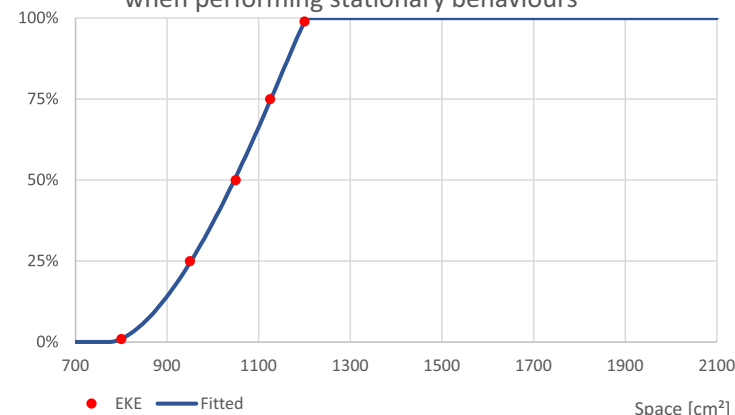


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of space (planimetric) for stationary behaviour in turkeys at 7 kg

- Planimetric measurements were found for toms (B.U.T. 6) of different weights in Spindler et al. (2016 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover), Kulke et al. (2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover), Ellerbrock and Knierim (2002), and Graue et al. (2013). Data of Graue et al. (2013) were discussed. Extrapolation was done from 20 kg per allometric scaling.
- Measurements were taken on single birds (sitting or standing in relaxed position) in isolated situations
- Photographs were analysed using colour contrast planimetric method KobaPlan which is a standard methodology

Main uncertainties

- Differences between genotypes and extrapolation of the available data to other genotypes (e.g. medium lines, traditional genotypes)
- Differences between toms and hens and extrapolation of the available data to hens

Reasoning for a scenario which would lead to a reasonable high proportion	The judgement on the upper limit considers that • Weight class consists mainly of hens, which may occupy more space (less tall, less dense) • If traditional breeds are used, they may occupy more space (less tall, less dense) • Variation shown in the references, esp. reported value in Spindler et al. (2016 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover)
Reasoning for a scenario which would lead to a reasonable low proportion	The judgement on the lower limit considers that • Graue et al. (2013) reported on average lower space requirements • Allometric scaling from 20kg birds would indicate lower space requirements
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • Hens or traditional breeds are the main bird categories having a slaughter weight of 7kg
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • Larger uncertainties on values below the median in the evidence base • Medium uncertainties on values above the median

Experts

Jutta BERK, Joanna MARCHEWKA, Anja B. RIBER, Nienke VAN STAVEREN, Antonio VELARDE CALVO

Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO, Oana-Maria BALMOS
Observers	NA
Date and place of the EKE	12th July 2024 as online meeting

D – EKE results on space for stationary behaviour in turkeys at 12 kg and summary of evidence used

Overview of the results of the expert knowledge elicitation															
Parameter	Space (planimetric) occupied by the bird when performing stationary behaviours, e.g. standing, resting, sitting, feeding and drinking														
Stratification	Turkeys (hens/toms, all genotypes) with a slaughter weight of 12 kg														
Question	What is the average space on the ground that the turkeys shortly before slaughter occupy with their bodies when performing stationary behaviour ?														
Unit	[cm ²]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	1200					1275		1350		1425					1500
EKE results	1200	1205	1213	1229	1250	1275	1300	1350	1400	1425	1450	1471	1487	1495	1500
Fitted distribution	BetaGeneral (1.0476, 1.0505, 1196.5, 1504)														

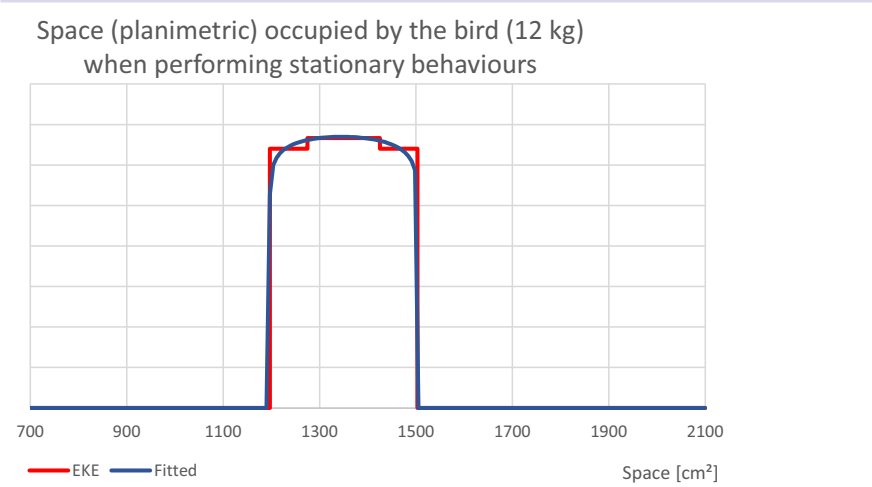


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

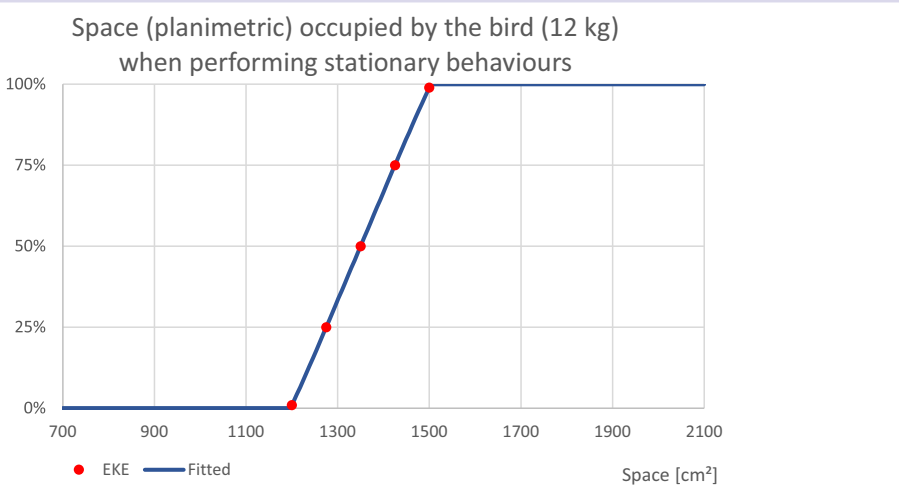


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

- Planimetric measurements were found for toms (B.U.I. 6) of different weights in Spindler et al. (2016) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover), Kulke et al. (2017) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover), Ellerbrock and Knierim (2002), and Graue et al. (2013). Data of Graue et al. (2013) (Figure 3) were discussed. Extrapolation was done from 20 kg per allometric scaling.
- Measurements were taken on single birds (sitting or standing in relaxed position) in isolated situations
- Photographs were analysed using colour contrast planimetric method KobaPlan which is a standard methodology

- Differences between genotypes and extrapolation of the available data to other genotypes (e.g. medium lines, traditional genotypes)
- Differences between toms and hens and extrapolation of the available data to hens

Reasoning for a scenario which would lead to a reasonable high proportion	The judgement on the upper limit considers that • Weight class consists of hens, which may occupy more space (less tall, less dense) • If traditional breeds are used, they may occupy more space (less tall, less dense)
Reasoning for a scenario which would lead to a reasonable low proportion	The judgement on the lower limit considers that • Graue et al. (2013) reported on average lower space requirements • Allometric scaling from 20 kg birds would indicate lower space requirements
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • Average space as reported for toms at a slaughter weight of 12 kg • Small effect of sex and breed at this weight class
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • High (remaining) uncertainties on values below the median • High (remaining) uncertainties on values above the median
Experts	Jutta BERK, Joanna MARCHEWKA, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO, Oana-Maria BALMOS
Observers	NA
Date and place of the EKE	12 July 2024 as online meeting

Overview of the results of the expert knowledge elicitation															
Parameter	Space (planimetric) occupied by the bird when performing stationary behaviours, e.g. standing, resting, sitting, feeding and drinking														
Stratification	Turkeys (hens/toms, all genotypes) with a slaughter weight of 16 kg														
Question	What is the average space on the ground that the turkeys shortly before slaughter occupy with their bodies when performing stationary behaviour ?														
Unit	[cm ²]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	1250					1400		1550		1625					1700
EKE results	1250	1264	1284	1319	1362	1410	1454	1534	1603	1634	1662	1681	1693	1698	1701
Fitted distribution	BetaGeneral (1.182, 0.79036, 1238.5, 1702)														

Space (planimetric) occupied by the bird (16 kg)
when performing stationary behaviours

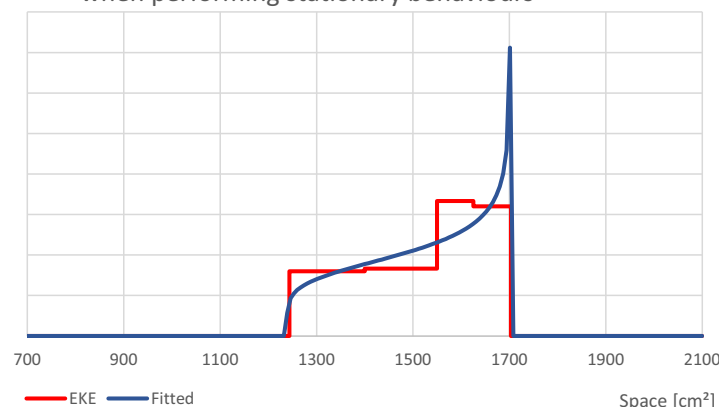


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Space (planimetric) occupied by the bird (16 kg)
when performing stationary behaviours

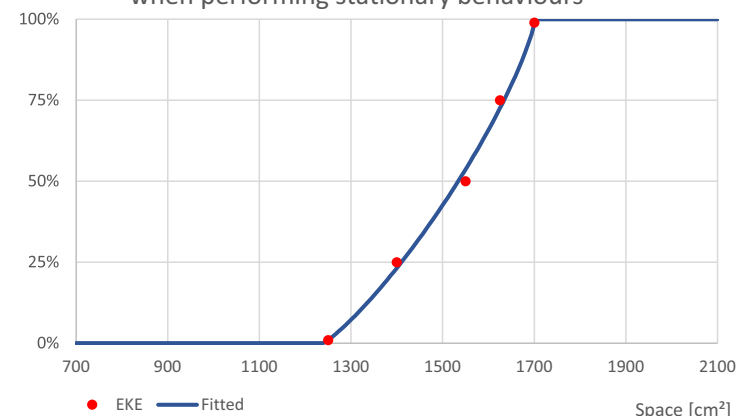


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of space (planimetric) for stationary behaviour in turkeys at 16 kg

- Planimetric measurements were found for toms (B.U.T. 6) of different weights in Spindler et al. (2016 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover), Kulke et al. (2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover), Ellerbrock and Knierim (2002), and Graue et al. (2013). Data of Graue et al. (2013) were discussed. Extrapolation was done from 20 kg per allometric scaling.
- Measurements were taken on single birds (sitting or standing in relaxed position) in isolated situations
- Photographs were analysed using colour contrast planimetric method KobaPlan which is a standard methodology

Main uncertainties

- Differences between genotypes and extrapolation of the available data to other genotypes (e.g. medium lines, traditional genotypes)
- Differences between toms and hens and extrapolation of the available data to hens

Reasoning for a scenario which would lead to a reasonable high proportion

- The judgement on the upper limit considers that
- Weight class consists mainly of toms with reported values
 - Ellerbrock and Knierim (2002) reported high value for this weight class

Reasoning for a scenario which would lead to a reasonable low proportion

- The judgement on the lower limit considers that
- Graue et al. (2013) reported on average lower space requirements
 - Allometric scaling from 20 kg birds would indicate lower space requirements

Fair estimate as judgement on the weighted evidence

- The judgement on the median considers that
- Average space as reported for toms at a slaughter weight of 16 kg

Precision of the judgement as description of remaining uncertainties

- The judgement on the interquartile range considers that
- High (remaining) uncertainties on values below the median
 - High (remaining) uncertainties on values above the median

Experts

Jutta BERK, Joanna MARCHEWKA, Anja B. RIBER, Nienke VAN STAVEREN, Antonio VELARDE CALVO

Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO, Oana-Maria BALMOS
Observers	na
Date and place of the EKE	12th July 2024 as online meeting

F – EKE results on space for stationary behaviour in turkeys at 20 kg and summary of evidence used

Overview of the results of the expert knowledge elicitation															
Parameter	Space (planimetric measurements) occupied by the bird when performing stationary behaviours, e.g. standing, resting, sitting, feeding and drinking														
Stratification	Turkeys (hens/toms, all genotypes) with a slaughter weight of 25 kg														
Question	What is the average space on the ground that the turkeys shortly before slaughter occupy with their bodies when performing stationary behaviour ?														
Unit	[cm ²]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	1550					1675		1800		1900					2000
EKE results	1550	1560	1575	1602	1637	1678	1718	1795	1868	1903	1938	1965	1985	1995	2000
Fitted distribution	BetaGeneral (1.1086, 0.96959, 1543, 2004)														

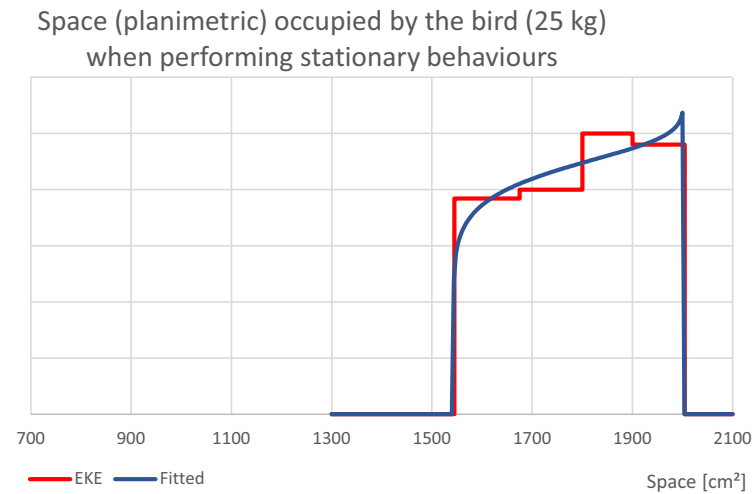


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

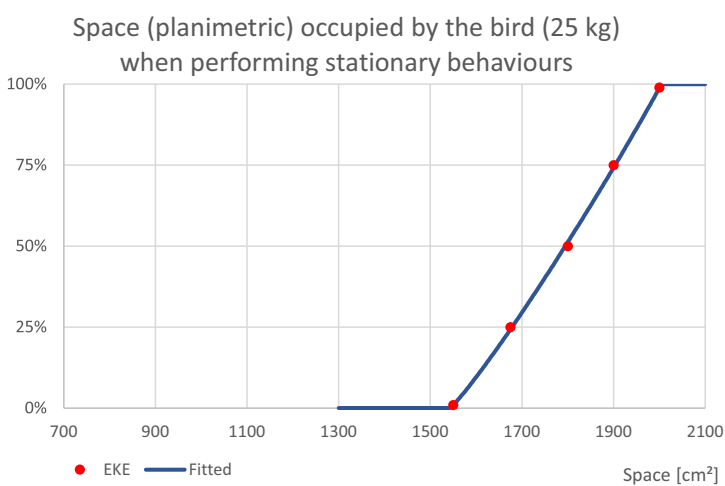


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation

- Planimetric measurements were found for toms (B.U.T. 6) of different weights in Spindler et al. (2016 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover), Kulke et al. (2017 retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal welfare and Farm animal behaviour (ITTN) University of Veterinary Medicine Hannover), Ellerbrock and Knierim (2002), and Graue et al. (2013). Data of Graue et al. (2013) were discussed. Extrapolation was done from 20 kg per allometric scaling.
- Measurements were taken on single birds (sitting or standing in relaxed position) in isolated situations
- Photographs were analysed using colour contrast planimetric method KobaPlan which is a standard methodology

Main uncertainties

- Differences between genotypes and extrapolation of the available data to other genotypes (e.g. medium lines, traditional genotypes)
- Differences between toms and hens and extrapolation of the available data to hens

Reasoning for a scenario which would lead to a reasonable high proportion	The judgement on the upper limit considers that • Weight class consists likely only of toms with reported values • Spindler et al. (2016) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover) reported higher values for high weights • Allometric scaling from 20 kg birds would indicate higher space requirements
Reasoning for a scenario which would lead to a reasonable low proportion	The judgement on the lower limit considers that • Graue et al. (2013) reported on average lower space requirements. • Spindler et al. (2016) retrieved from EFSA Public call for evidence 2024 - PC-0741 1 - Institute for Animal Hygiene, Animal Welfare and Farm animal behaviour (ITTN), University of Veterinary Medicine Hannover) reported a lower value for high weights • Older turkeys gain weight without larger space requirements
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • Likely increase of space for toms at a slaughter weight of 25 kg (compared to 20 kg)
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • High (remaining) uncertainties on values below the median • High (remaining) uncertainties on values above the median
Experts	Jutta BERK, Joanna MARCHEWKA, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO, Oana-Maria BALMOS
Observers	NA
Date and place of the EKE	12th July 2024 as online meeting

G – Data on morphological dimensions of turkeys

Batch information ^a	N	Body weight (kg) ^b		Neck to beak (cm) ^b	Head to beak (cm) ^b	Tail length (cm) ^b	Body length (cm) ^b	Body width (cm) ^b	Wing length (cm) ^b
		Observed weight	Target weight ^c						
(1) B.U.T. 6, toms, (16 w) 112d	10	15.4	16.2	29.2 (3.2)	16.1 (1.2)	27.1 (2.5)	51.9 (4.6)	34.3 (1.9)	61.6 (2.5)
(2) B.U.T. Premium, toms (19.3 w) 135 d	15	15.0	17.6	33.5 (2.4)	11.5 (1.0)	27.1 (3.7)	44.9 (2.8)	29.7 (2.4)	55.8 (4.0)
(3) B.U.T. Premium, hens, (12.9 w) 90 d	10	7.2	7.6	–	–	28.3 (0.8)	40.7 (1.5)	25.2 (1.2)	–
(4) B.U.T. Premium, hens, (13.3 w) 93 d	15	7.4	7.6	24.8 (2.6)	10.7 (0.8)	33.1 (2.0)	33.1 (2)	24.7 (1.6)	49.1 (1.6)
(5) B.U.T. Premium, hens, (13.9 w) 97 d	11	7.9	8.4	24.8 (1.8)	10.0 (0.4)	31.3 (2.0)	39.5 (3.1)	24.7 (1.2)	48.8 (2.3)

^aBatch information included genotype, sex, age as recorded in days or weeks. When age was recorded in days, the weeks were calculated and presented in brackets and vice versa. Batch 1 (Berk, 2024b personal communication) and batches 2–5 (Ribalta Alet & Campoy Atlés, IRTA 2024 personal communication).

^bValues presented as mean (SD (Standard Deviation)) where applicable.

^cTarget weight as per B.U.T. 6 (Aviagen Turkeys, 2022a) or B.U.T. Premium performance goals (Aviagen Turkeys, 2022b).

H – Adjustment factors calculated for hens and toms for each behavioural class

Adjustment factors (mean [min-max]) for each behavioural category (dynamic, other comfort, wing flapping, dustbathing and strutting), derived from the morphological dimensions of turkeys engaged in each behaviour and expressed in relation to the space occupied during stationary behaviour (used as reference). Strutting is only performed by toms.

	Hens	Toms
Stationary behaviour	Reference (=1)	Reference (=1)
Dynamic behaviour	1.56 [1.55–1.57]	1.61 [1.59–1.63]
Other comfort behaviour	2.97 [2.95–2.99]	2.84 [2.80–2.88]
Wing flapping	4.26 [4.19–4.34]	3.97 [3.81–4.11]
Dustbathing	2.31 [2.30–2.33]	2.23 [2.20–2.25]
Strutting	–	1.43 [1.41–1.46]

I – EKE results on inter-individual distance of hens and summary of the evidence used

Overview of the results of the expert knowledge elicitation

Parameter	Inter-individual distance of turkey hens														
Stratification	Hens														
Question	What is the average inter-individual distance between turkey hens (free space) while performing their behaviours?														
Unit	[cm]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	15					25		30		45					60
EKE results	15.1	16.0	17.2	19.1	21.3	23.9	26.5	31.8	38.1	42.1	47.3	53.3	60.8	67.7	76.3
Fitted distribution	Weibull (1.5102, 22.646, RiskShift (14))														

Inter-individual distance of turkey hens

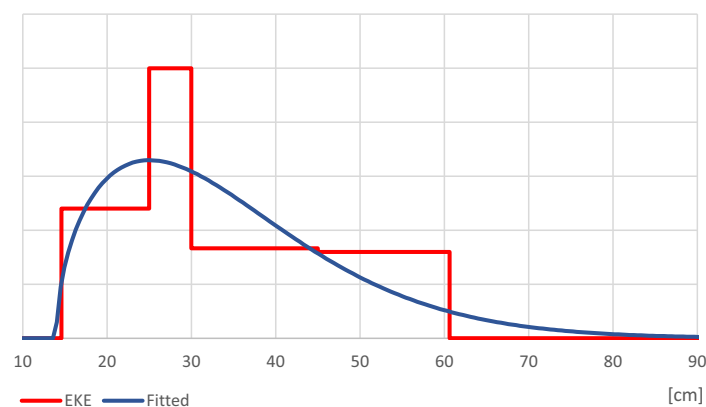


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Inter-individual distance of turkey hens

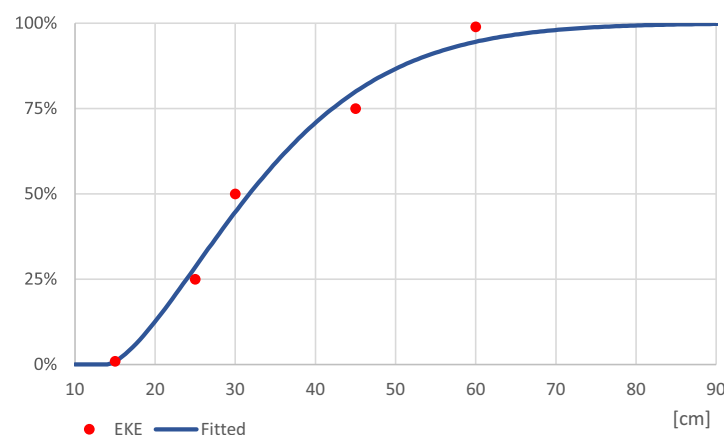


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of inter-individual distance in hens

- Measurements of morphological dimensions of B.U.T. Premium turkey hens (3 batches) by Ribalta Alet and Campoy Atlés (IRTA 2024 personal communication)
- Paper of Buchwalder and Huber-Eicher (2004) on negative behaviours when introducing a turkey in small groups of turkeys in an experimental set-up

Main uncertainties

- Missing specific studies on the inter-individual distances during specific behaviours performed by turkeys and in unrestricted conditions
- Interpretation of morphological dimensions and negative behaviour for inter-individual distances
- Data were collected from B.U.T. Premium hens which is a medium line, heavy lines may have a longer neck-to-beak length

J – EKE results on inter-individual distance of toms and summary of the evidence used

Parameter	Inter-individual distance of turkey toms														
Stratification	Toms														
Question	What is the average inter-individual distance between turkey toms (free space) while performing their behaviours?														
Unit	[cm]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	20					35		40		55					70
EKE results	19.9	21.8	23.8	26.8	30.0	33.3	36.3	42.3	48.8	52.7	57.5	62.9	69.3	75.0	81.7
Fitted distribution	Weibull (1.5102, 22.646) + 14 (Shift)														

Inter-individual distance of turkey toms

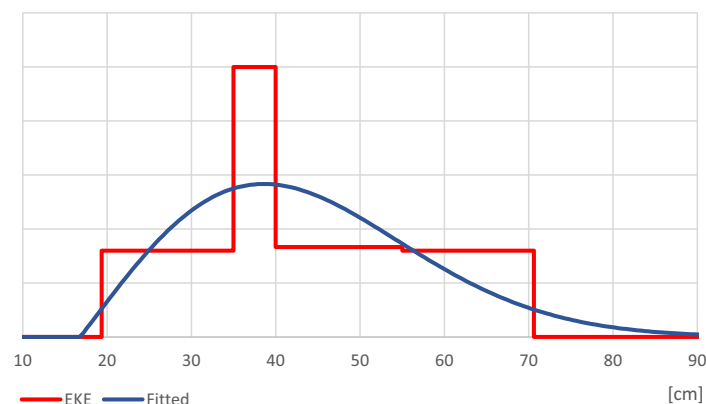


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Inter-individual distance of turkey toms

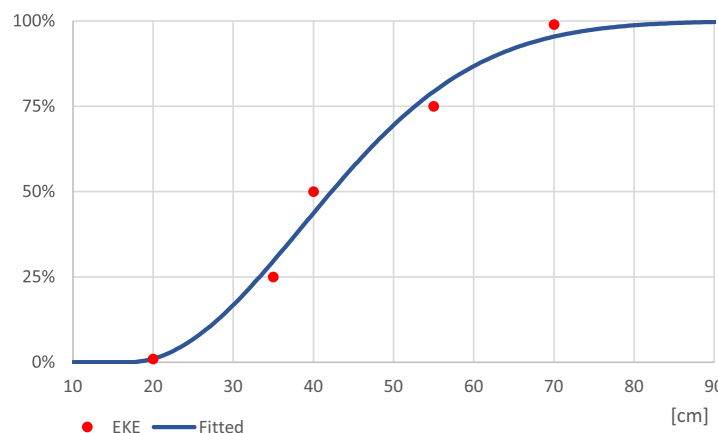


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of inter-individual dist in toms

- Measurements of morphological dimensions B.U.T. premium turkey toms (1 batch) by Ribalta Alet and Campoy Atlés (IRTA 2024 personal communication) and B.U.T. 6 toms (1 batch) by Berk (2024b personal communication)
- Paper of Buchwalder and Huber-Eicher (2004) on negative behaviours when introducing a turkey in small groups of turkeys in an experimental set-up

Main uncertainties

- Missing specific studies on the inter-individual distances during specific behaviours performed by turkeys and in unrestricted situations
- Interpretation of morphological dimensions and negative behaviour for inter-individual distances

Reasoning for a scenario which would lead to a reasonable high proportion

The judgement on the upper limit considers that

- it was assumed that toms try to avoid possible contacts during different behaviours e.g. during wing flapping a distance of twice the wing length is assumed to be needed; during dynamic behaviour a distance of twice the body length is assumed to be needed
- it was assumed that toms try to protect against injurious pecking by distancing themselves from a conspecific more than twice the neck-to-beak length
- toms are heavier and have a larger body which justifies a higher upper bound limit than hens

Reasoning for a scenario which would lead to a reasonable low proportion

The judgement on the lower limit considers that

- toms try to distance themselves from a conspecific with the space required estimated to be a bit less than the average neck-to-beak length
- toms are heavier and have a larger body which justify a higher lower limit than hens

Fair estimate as judgement on the weighted evidence

The judgement on the median considers that

- stationary behaviour is more frequent than dynamic behaviours, therefore the median is shifted to lower values

Precision of the judgement as description of remaining uncertainties

The judgement on the interquartile range considers that

- high uncertainties below the median due to observed close distances in case of limited space (commercial setting)
- high uncertainties above the median due to Buchwalder and Huber-Eicher (2004) results on injurious pecking

Experts

Jutta BERK, Joanna MARCHEWKA (online), Virginie MICHEL, Anja B. RIBER, Nienke VAN STAVEREN, Antonio VELARDE CALVO

Facilitator/Reporter

Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO, Oana-Maria BALMOS

Observers

Chiara FABRIS

Date and place of the EKE

16th October 2024 at EFSA

K – EKE results on the percentage of strutting behaviour and summary of evidence

Overview of the results of the expert knowledge elicitation

Parameter	Percentage of time toms spent on strutting behaviour														
Stratification	Toms														
Question	Assuming the average percentage of time that turkeys (toms only) spend strutting during the light period (photophase), and accounting for variation between flocks due to different farming conditions within the scenario, what percentage of time does the 75 th percentile flock spend performing this behaviour?														
Unit	[% of time during photophase]														
Percentiles	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	0.5%					2.0%		3.5%		5.2%					7.0%
EKE results	0.5%	0.6%	0.7%	1.1%	1.5%	2.0%	2.5%	3.5%	4.6%	5.2%	5.8%	6.2%	6.6%	6.9%	7.0%
Fitted distribution	BetaGeneral (1.021, 1.132, 0.435, 7.105)														

Average percentage of time the toms performing strutting

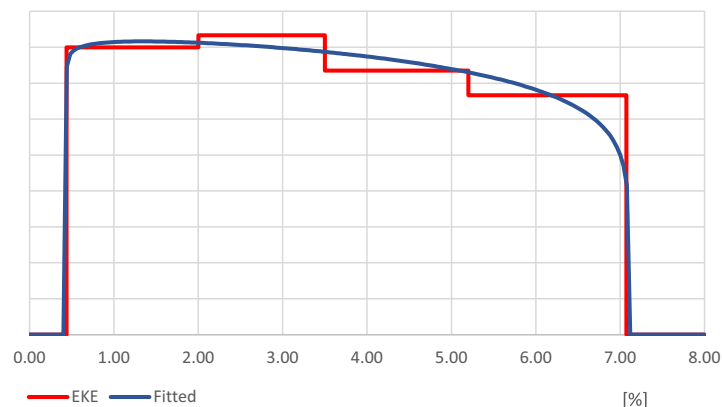


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time the toms performing strutting

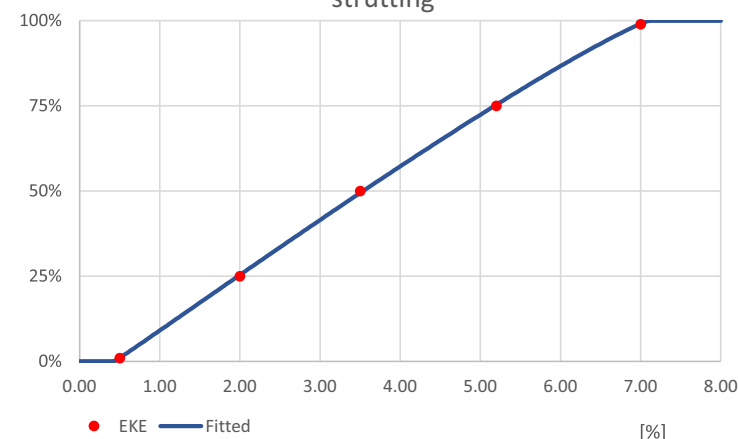


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation percentage of time spent on strutting by toms

- Results of Vermette et al. (2016a) and Sherwin and Kelland (1998) as background information

Main uncertainties

- Small evidence base: only one study at two ages (11 and 17 weeks), only 4 observations were available
- Observations were done at high stocking density, with unknown effect on the behaviour
- Strutting might be shown only in specific life stages of toms

Reasoning for a scenario which would lead to a reasonable high proportion

The judgement on the upper limit considers that

- observations of high proportion of strutting by EFSA experts which is supported by the evidence in Sherwin and Kelland (1998)
- high stocking density may suppress this behaviour, Vermette et al. (2016a) may underestimate the frequency of strutting
- observations may not cover the specific life stages of the toms, Vermette et al. (2016a) may underestimate

Reasoning for a scenario which would lead to a reasonable low proportion

The judgement on the lower limit considers that

- observations of low proportion of strutting
- high stocking density may promote this behaviour by increased stimuli, Vermette et al. (2016a) may underestimate

Fair estimate as judgement on the weighted evidence	The judgement on the median considers that - EKE question refers to the 75th percentile of variation between flocks, this means farming conditions which enable or promote strutting above the average - limited evidence, this means no tendency to low or high percentages
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that there is high uncertainty below and above the median
Experts	Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO
Observers	NA
Date and place of the EKE	09th December 2024 as online meeting

L – EKE results on the percentage of time spent on wing flapping and summary of evidence used

Overview of the results of the expert knowledge elicitation															
Parameter	Percentage of time spent on wing flapping														
Stratification	None														
Question	Assuming the average percentage of time that turkeys spend wing flapping during the light period, and accounting for variation between flocks due to different farming conditions within the scenario, what percentage of time does the 75th percentile flock spend performing this behaviour?														
Unit	[% time during photophase]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	0.1%					0.3%		0.5%		0.7%					1.5%
EKE results	0.10%	0.12%	0.15%	0.20%	0.25%	0.31%	0.36%	0.48%	0.63%	0.72%	0.84%	0.98%	1.15%	1.31%	1.51%
Fitted distribution	BetaGeneral (2.0165, 16.422, 0.06, 4.5)														

Average percentage of time spent on wing flapping

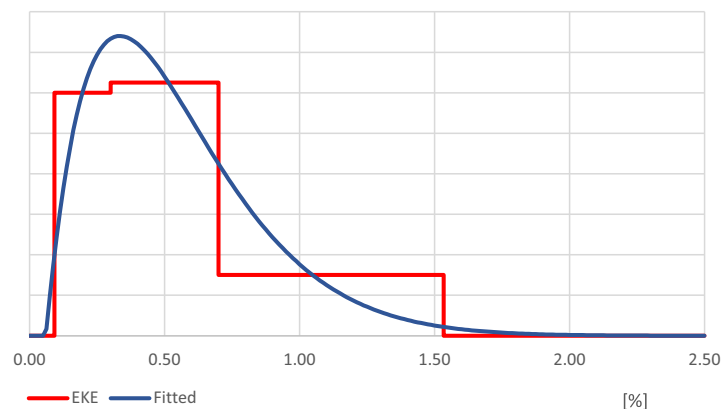


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time spent on wing flapping

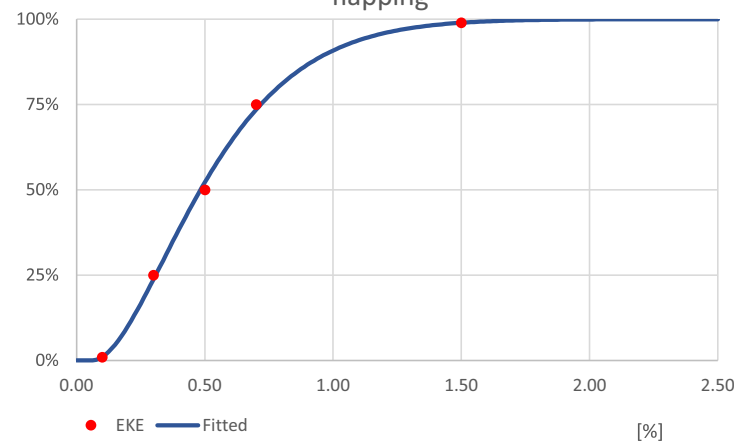


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

- Results of Hammond et al. (2024) and Jhetam et al. (2022b)

- ## Main uncertainties

- Small evidence base: Only two studies and few observations were available (17 observations)

- Reasoning for a scenario which The judgement on the upper limit considers that

would lead to a reasonable high proportion	- wing flapping maybe overlooked in the observations, due to the measurement method (studies underestimate) - High stocking density may suppress this behaviour (studies underestimate) - EKE question refers to the 75th percentile of variation between flocks, this means farming conditions which enable or promote wing flapping above the average
Reasoning for a scenario which would lead to a reasonable low proportion	The judgement on the lower limit considers that - Wing flapping is not synchronised between turkeys, therefore (better) measurable - High stocking density may promote this behaviour (aggressive behaviour, studies overestimate)
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that - General tendency to lower percentage - Observations may underestimate the value, due to limitation in measurements, high stocking density
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that - High uncertainty below the median - Low uncertainty above the median/high values are less likely
Experts	Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO
Observers	NA
Date and place of the EKE	09th December 2024 as online meeting

Average percentage of time spent on dust bathing

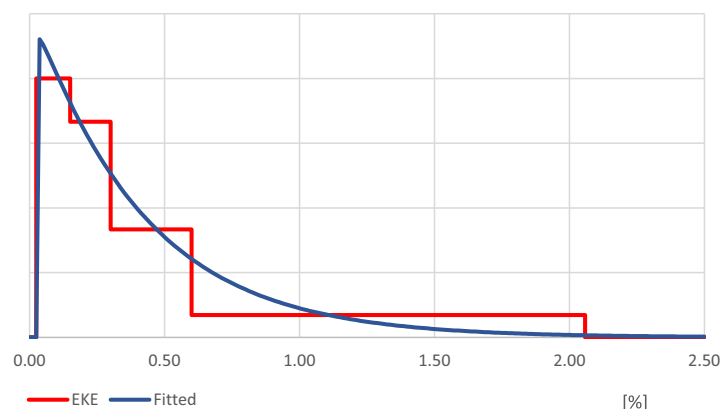


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time spent on dust bathing

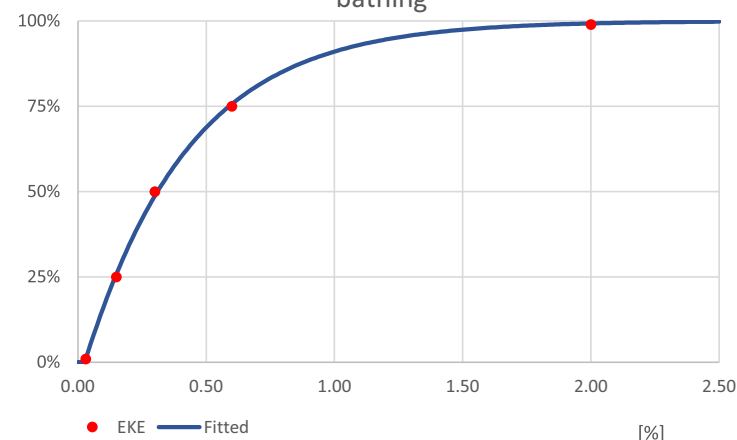


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of percentage of time spent on dustbathing

- Results of Jhetam et al. (2022b)

Main uncertainties

- Small evidence base: Only one study, with 8 observations were available
- Known dependence on time of day, light and floor situation, more synchronised behaviour
- Farming conditions of the study were not promoting this behaviour: high stocking density, no natural light

Reasoning for a scenario which would lead to a reasonable high proportion

The judgement on the upper limit considers that

- EKE question refers to the 75th percentile of variation between flocks, this means farming conditions which enable or promote this behaviour above the average
- The study underestimates the percentage due to farming conditions: stocking density, litter condition, no natural light
- Assumption of at least 1 dustbathe per day lasting 20–25 min (as it lasts in laying hens); it is said that wild turkeys dustbathe daily or every second day
- Birds performing dustbathing will motivate other to do the same behaviour

Reasoning for a scenario which would lead to a reasonable low proportion

The judgement on the lower limit considers

- Observations with low percentage of dustbathing
- High stocking density may promote this behaviour (by increased stimuli, study overestimates)

Fair estimate as judgement on the weighted evidence

The judgement on the median considers that

- The observations likely underestimate the percentage
- Comparison with wild turkeys is unlikely valid for farming conditions

Precision of the judgement as description of remaining uncertainties

The judgement on the interquartile range considers that

- High uncertainties below the median
- Low uncertainties above the median/high values are less likely

Experts

Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO

Facilitator/Reporter

Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO

Observers

NA

Date and place of the EKE

09th December 2024 as online meeting

N – EKE results on the percentage of time of other comfort behaviour and summary of evidence used

Overview of the results of the expert knowledge elicitation															
Parameter	Percentage of time of other comfort behaviour (e.g. preening, wing stretching)														
Stratification	None														
Question	Assuming the average percentage of time that turkeys spend performing other comfort behaviours (such as preening and wing stretching) during the light period, and accounting for variation between flocks due to different farming conditions within the scenario, what percentage of time does the 75 th percentile flock spend performing these behaviours?														
Unit	[% of time during photophase]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	5%					7%		9%		12%					15%
EKE results	5.0%	5.1%	5.3%	5.6%	6.2%	6.9%	7.6%	9.2%	10.9%	11.9%	12.9%	13.7%	14.4%	14.8%	15.1%
Fitted distribution	BetaGeneral (0.90558, 1.1763, 4.95, 15.3)														

Average percentage of time spent on other comfort behaviour

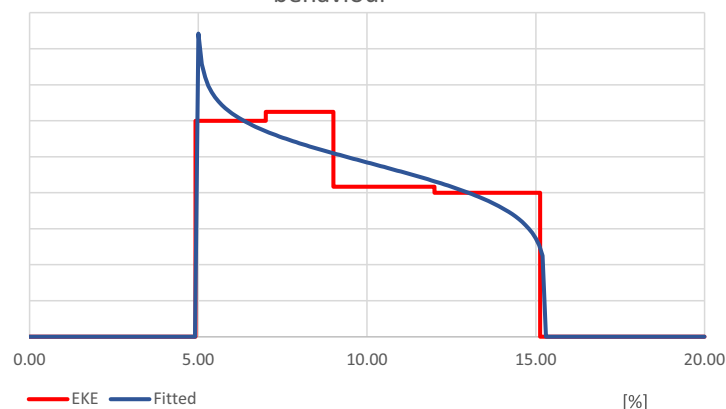


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Summary of the evidence used for the evaluation of percentage of time spent on other comfort behaviour

- Results of Beaulac and Schwan-Lardner (2018), Hammond et al. (2024a), Jhetam et al. (2022b) and Vermette et al. (2016)

Main uncertainties

- Influence of farming conditions, incl. stocking density, sex and age of the turkey

Reasoning for a scenario which would lead to a reasonable high proportion

The judgement on the upper limit considers that

- observations with high percentage in the evidence base
- high stocking density may suppress this behaviour (studies underestimate the percentage)

Reasoning for a scenario which would lead to a reasonable low proportion

The judgement on the lower limit considers that

- observations with low percentage in the evidence base
- decrease of the activity by age

Average percentage of time spent on other comfort behaviour

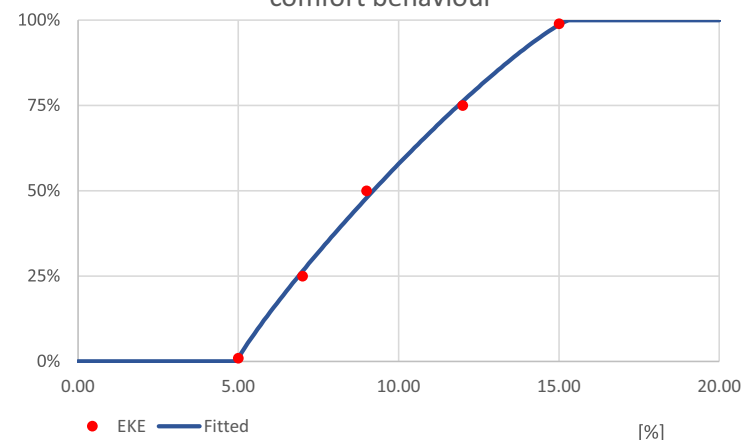


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Fair estimate as judgement on the weighted evidence	The judgement on the median considers that - EKE question refers to the 75th percentile of variation between flocks, this means farming conditions which enable or promote the percentage of time performing other comfort behaviours above the average - slightly decrease for the second half of their lifetime
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that high uncertainties below/above the median
Experts	Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO
Observers	NA
Date and place of the EKE	9 December 2024 as online meeting

O – EKE results on the percentage of time spent on dynamic behaviour by hens and summary of evidence used

Overview of the results of the expert knowledge elicitation															
Parameter	Percentage of time spent on dynamic behaviour by hens														
Stratification	Hens														
Question	Assuming the average percentage of time that hens spend performing dynamic behaviours during the light period, and accounting for variation between flocks due to different farming conditions within the scenario, what percentage of time does the 75 th percentile flock spend performing these behaviours? [% dynamic behaviour]														
Unit	[% during photophase]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Elicited values	13%					20%		25%		30%					35%
EKE results	13.0%	13.7%	14.7%	16.2%	18.0%	19.9%	21.7%	25.1%	28.3%	29.9%	31.6%	32.9%	34.0%	34.6%	35.0%
Fitted distribution	BetaGeneral (1.4154, 1.1916, 12.25, 35.4)														

Average percentage of time the hens spent on dynamic behaviour

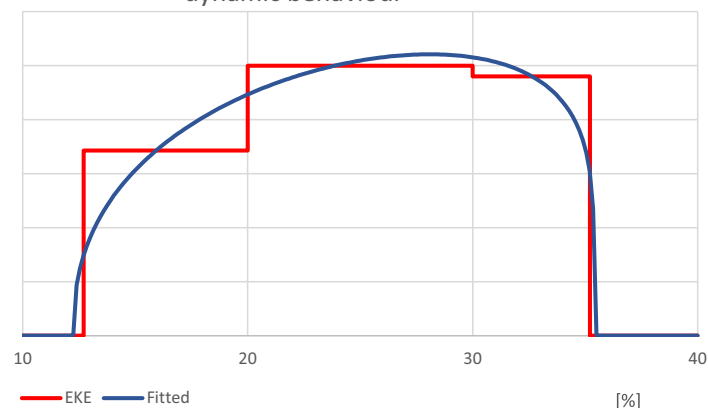


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time the hens spent on dynamic behaviour

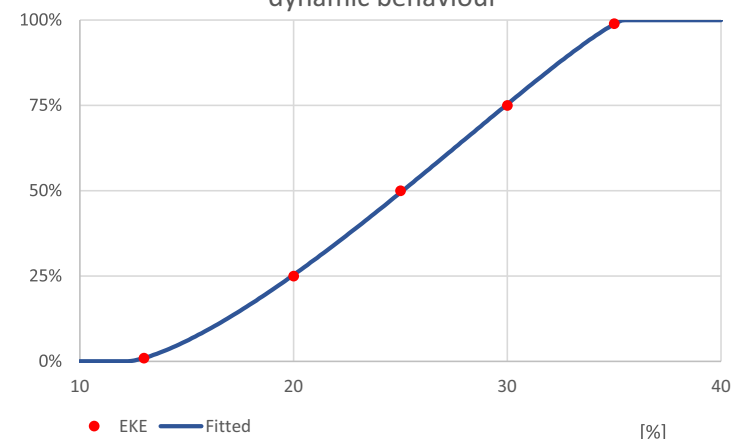


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

- Results of Hammond et al. (2024) and Jhetam et al. (2022b)

- Small evidence base: Only two studies, 17 observations were available
- Farming conditions of the studies were not promoting this behaviour: high stocking density, type of bedding material, lack of enrichment

Reasoning for a scenario which would lead to a reasonable high proportion	The judgement on the upper limit considers that • observations with high percentage of the dynamic behaviour in the evidence base • the studies underestimate the percentage due to farming conditions: stocking density, bedding material, lack of enrichment
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Reasoning for a scenario which would lead to a reasonable low proportion	The judgement on the lower limit considers that • observations with low percentage of the dynamic behaviour in the evidence base • decrease of the percentage of dynamic behaviour by age • (The study underestimates the percentage also for low values)
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Fair estimate as judgement on the weighted evidence	The judgement on the median considers that - the studies underestimate the percentage of dynamic behaviour - EKE question refers to the 75th percentile of variation between flocks, this means farming conditions which enable or promote this behaviour above the average
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Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • low/median uncertainty below the median/lower values are less likely • high uncertainty above the median
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Experts	Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO
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Facilitator/Reporter	Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO
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Observers	NA
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Date and place of the EKE	09th December 2024 as online meeting
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Overview of the results of the expert knowledge elicitation

Parameter	Percentage of time spent on dynamic behaviour of toms
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Stratification	Toms
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Question Assuming the average percentage of time that toms spend performing dynamic behaviours during the light period, and accounting for variation between flocks due to different farming conditions within the scenario, what percentage of time does the 75th percentile flock spend performing these behaviours?

Unit	[% of time during the photophase]
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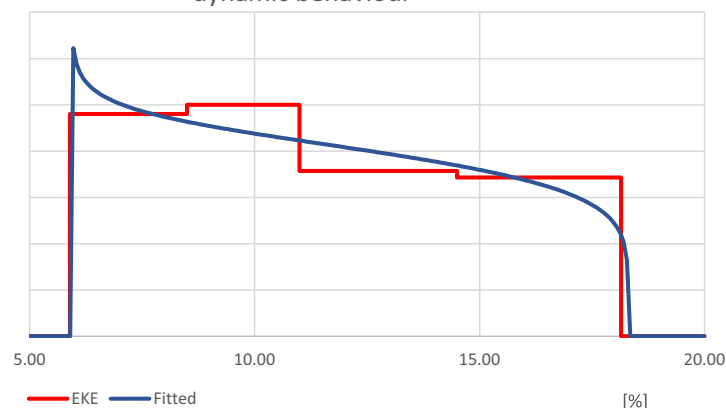
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
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Elicited values	6.0%		8.5%		11.0%	14.5%		18.0%
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EKE results	6.0%	6.1%	6.4%	6.8%	7.5%	8.4%	9.3%	11.2%	13.3%	14.4%	15.5%	16.5%	17.3%	17.8%	18.1%
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Fitted distribution	BetaGeneral (0.93246, 1.1552, 5.92, 18.3)
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Average percentage of time the toms spent on dynamic behaviour



Average percentage of time the toms spent on dynamic behaviour

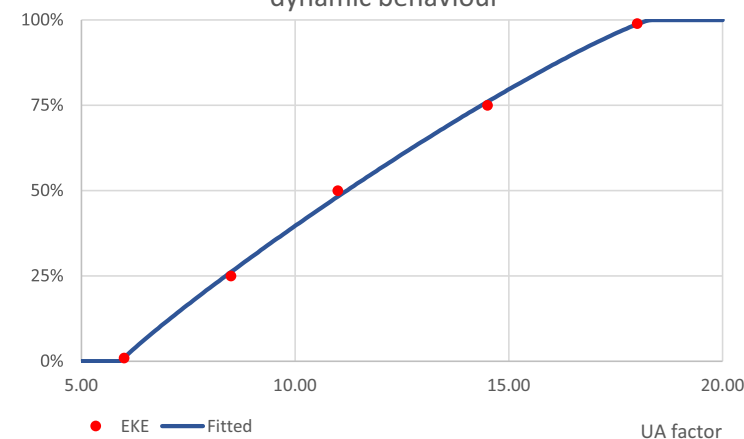


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

Summary of the evidence used for the evaluation of percentage of time spent on dynamic behaviour (toms)

- Results of Beaulac and Schwean-Lardner (2018) and Vermette et al. (2016a)

Main uncertainties

- Small evidence base: Only two studies, few observations were available (16 observations)
- Farming conditions of the study were not promoting this behaviour: high stocking density, type of bedding material, lack of enrichment
- Toms are heavier and show less dynamic behaviour in comparison to hens
- Unclear behaviour at older ages

Reasoning for a scenario which would lead to a reasonable high proportion

The judgement on the upper limit considers that

- observations of high percentage of time spent on dynamic behaviour in the evidence base
- the studies underestimate the percentage due to farming conditions: stocking density, bedding material, lack of enrichment

Reasoning for a scenario which would lead to a reasonable low proportion

The judgement on the lower limit considers that

- observations with low percentage in the evidence base
- older toms may show less dynamic behaviour than younger toms

Fair estimate as judgement on the weighted evidence

The judgement on the median considers that

- the studies underestimate the percentage due to farming conditions: stocking density, bedding material, lack of enrichment
- EKE question refers to the 75th percentile of the variation between flocks, this means farming conditions which enable or promote dynamic behaviour above the average
- lower values of dynamic behaviour are slightly more likely

Precision of the judgement as description of remaining uncertainties

The judgement on the interquartile range considers that

- high uncertainties below/above the median

Experts

Jutta BERK, Joanna MARCHEWKA, Virginie MICHEL, Anja B. RIBER, Nienke VAN STAAVEREN, Antonio VELARDE CALVO

Facilitator/Reporter

Olaf MOSBACH-SCHULZ, Cristina ROJO GIMENO

Observers

NA

Date and place of the EKE

9th December 2024 as online meeting

Q – Calculation of percentage of time spent on stationary behaviour (hens)

Overview of the results of the calculation of the percentage of time for stationary behaviour															
Parameter	Percentage of time of stationary behaviour of hens														
Stratification	Hens														
Calculation	Prop _{Stationary} = 100% - Prop _{Wing flapping} – Prop _{Dust bathing} – Prop _{Other Comf} – Prop _{Dynamic} (Hens)														
Unit	[% stationary behaviour]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Wing flapping	0.10%	0.12%	0.15%	0.20%	0.25%	0.31%	0.36%	0.48%	0.63%	0.72%	0.84%	0.98%	1.15%	1.31%	1.51%
Dust bathing	0.03%	0.04%	0.05%	0.07%	0.10%	0.15%	0.19%	0.31%	0.47%	0.59%	0.75%	0.96%	1.23%	1.51%	1.87%
Other comfort	5.00%	5.10%	5.27%	5.64%	6.17%	6.88% AUTHOR: Please check red font has been removed from Table Q and R.	7.62%	9.20%	10.93%	11.86%	12.85%	13.71%	14.41%	14.81%	15.07%
Dynamic behaviour	13.0%	13.7%	14.7%	16.2%	18.0%	19.9%	21.7%	25.1%	28.3%	29.9%	31.6%	32.9%	34.0%	34.6%	35.0%
Stationary	46.8%	48.1%	49.7%	51.6%	53.4%	55.2%	56.8%	60.1%	63.7%	65.5%	67.5%	69.5%	71.8%	73.2%	74.6%

Average percentage of time the hens spent on stationary behaviour

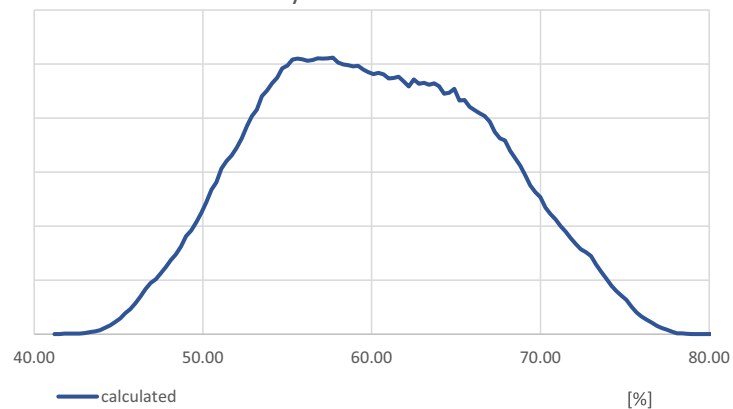


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time the hens spent on stationary behaviour

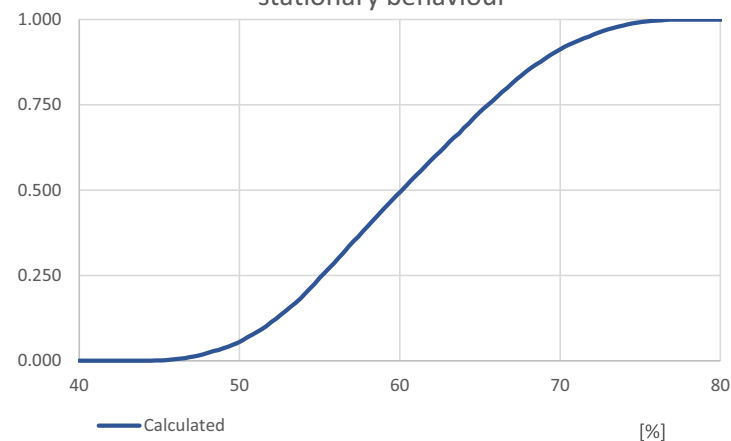


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

R – Calculation of percentage of time spent on stationary behaviour (toms)

Overview of the results of the calculation of the percentage of time for stationary behaviour

Parameter	Percentage of time of stationary behaviour of toms														
Stratification	Toms														
Calculation	$\text{Prop}_{\text{Stationary}} = 100\% - \text{Prop}_{\text{Strutting}}(\text{Toms}) - \text{Prop}_{\text{Wing flapping}} - \text{Prop}_{\text{Dust bathing}} - \text{Prop}_{\text{Other Comf}} - \text{Prop}_{\text{Dynamic}}(\text{Toms})$														
Unit	[% stationary behaviour]														
Results	P1%	P2.5%	P5%	P10%	P16.7%	P25%	P33.3%	P50%	P66.7%	P75%	P83.3%	P90%	P95%	P97.5%	P99%
Strutting	0.50%	0.59%	0.75%	1.06%	1.47%	1.98%	2.49%	3.54%	4.62%	5.18%	5.76%	6.25%	6.64%	6.85%	6.99%
Wing flapping	0.10%	0.12%	0.15%	0.20%	0.25%	0.31%	0.36%	0.48%	0.63%	0.72%	0.84%	0.98%	1.15%	1.31%	1.51%
Dust bathing	0.03%	0.04%	0.05%	0.07%	0.10%	0.15%	0.19%	0.31%	0.47%	0.59%	0.75%	0.96%	1.23%	1.51%	1.87%
Other comfort	5.00%	5.10%	5.27%	5.64%	6.17%	6.88%	7.62%	9.20%	10.93%	11.86%	12.85%	13.71%	14.41%	14.81%	15.07%
Dynamic behaviour	6.00%	6.12%	6.35%	6.83%	7.50%	8.38%	9.29%	11.21%	13.27%	14.36%	15.52%	16.51%	17.31%	17.76%	18.05%
Stationary	57.6%	59.2%	60.7%	62.4%	64.0%	65.6%	66.8%	69.2%	71.4%	72.7%	74.1%	75.5%	77.1%	78.3%	79.4%

Average percentage of time the toms spent on stationary behaviour

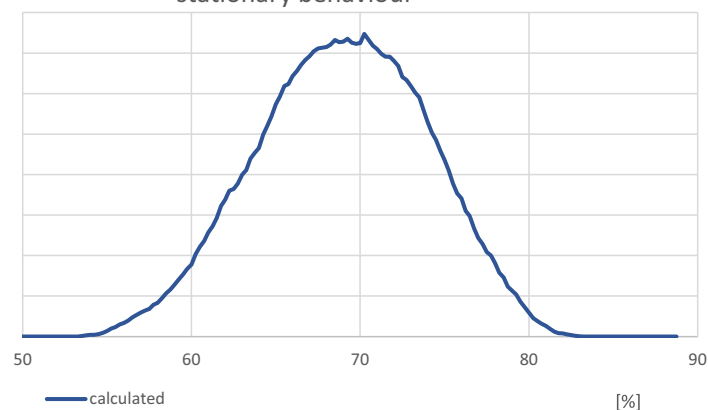


Figure (a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

Average percentage of time the toms spent on stationary behaviour

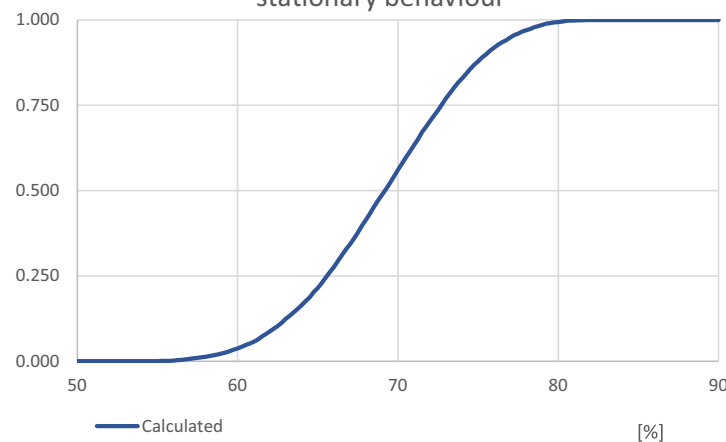


Figure (b): Cumulative distribution function (CDF) of the likelihood of the parameter

APPENDIX D

Uncertainty analysis of conclusions

Chapter	Number	Conclusions	Uncertainty question: How certain are you regarding the statements below	Consensus judgement	Reason for low certainty
Nest conditions	3	Turkeys prefer loose nesting materials such as peat, sand and wood shavings.	A higher proportion of birds provided with loose material such as peat, sand and wood shavings in the nest will express more elements of the nesting behaviour compared with when astroturf is provided instead	90%–100%	
	7	The number of hens per nest reported in practice and in industry guidelines is between 4 and 7 hens per nest. Within this range, fewer hens per nest lower the risk of Inability to express pre-laying and nesting (maternal) behaviour, Group stress and Soft tissue lesions and integument damage (certainty range).	In 90% of the flocks with a hen/nest ratio of 4 hens/nest the proportion of birds experiencing Inability to express pre-laying and nesting (maternal) behaviour, Group stress as well as Soft tissue lesions and integument damage will be lower than when the ratio is 7 hens/nest.	66%–100%	
Mutilations-beak trimming	3	As currently practised, beak trimming causes acute pain (certainty: XX%–100%). EFSA experts are XX%–100% certain that it also leads to chronic pain	More than 5% of birds that undergo infrared beak trimming experience acute pain. More than 5% of birds that undergo infrared beak trimming experience chronic pain lasting longer than 5 days.	Acute pain: 90%–100% Chronic pain: 66%–100%	
	5	Beak trimming effectively reduces the damage caused by injurious pecking	In flocks with stocking density above EFSA recommendations and barren environments, the likelihood and magnitude (duration × severity) of damage caused by injurious pecking are expected to be lower in flocks subjected to beak trimming compared with those in which no beak trimming is performed	90%–100%	
	6	However, Soft tissue lesions and integument damage inflicted by beak-intact turkeys performing injurious pecking is prevented if appropriate housing conditions and management practices are in place	When housing conditions follow the recommendations in this SO in terms of stocking density and provision of enrichment: in more than 90% of the flocks the likelihood and magnitude (duration × severity) of damage caused by injurious pecking will not differ between regardless of whether beak trimming is performed	66%–100%	
	9	The severity of the Soft and nervous tissue damage caused by beak trimming increases with the age of the turkey at the time of the procedure	A higher proportion of birds subjected to beak trimming will experience chronic (for >5 days) and acute pain when the procedure is performed after 10 days of age compared with birds that are beak trimmed when they are 1 day old.	66%–100%	

(Continued)

Chapter	Number	Conclusions	Uncertainty question: How certain are you regarding the statements below	Consensus judgement	Reason for low certainty
Mutilations-desnooding	3	Desnooding also impairs thermoregulation and exacerbates the likelihood of Heat stress under high environmental effective temperatures.	Under conditions of high environmental effective temperature, a higher proportion of desnooded toms will experience Heat stress compared with toms that are kept snood-intact when the hazard of high environmental effective temperatures is present	66%–100%	
	4	In snood-intact turkeys, Soft tissue lesions and integument damage due to injuries pecking at the snood is prevented if appropriate housing and management practices are in place.	When housing conditions meet the recommendations in this SO in terms of stocking density, provision of enrichment and light conditions the proportion of breeder and meat tom flocks in which birds experience damage to the snood due to injurious pecking is not expected to differ in more than 90% of cases, regardless of whether desnooding is performed.	66%–100%	
Mutilations-toe trimming	5	When kept under conventional housing conditions, intact toes increase the risk of Soft tissue lesions and integument damage (i.e. ABM scratches) in turkey hens, but not in toms.	Hens: Under conventional housing conditions with stocking densities exceeding the recommendations of this scientific opinion and barren environments, a higher proportion of hens in flocks with intact toes will experience scratches in the back compared with a flock of toe-trimmed hens. Toms: A higher proportion of toms in flocks with intact toes that will experience scratches in the back will not be different from flocks with toe-trimmed flocks.	Hens: 66%–100% Toms: 66%–100%	
	6	The damage caused by intact toes of hens can be prevented if appropriate housing conditions and management practices are in place. The damage caused by intact toes of toms can be prevented if appropriate housing conditions and management practices are in place.	In 90% of the flocks when housing conditions follow the recommendations in this SO in terms of stocking density and provision of enrichment, the proportion of hens experiencing scratches caused by intact toes will not change regardless of whether toe trimming is performed. In 90% of the flocks when housing conditions follow the recommendations in this SO in terms of stocking density and provision of enrichment, the proportion of toms experiencing scratches caused by intact toes will not change regardless of whether toe trimming is performed.	Hens: 66%–100% Toms: 90%–100%	

(Continues)

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Chapter	Number	Conclusions	Uncertainty question: How certain are you regarding the statements below	Consensus judgement	Reason for low certainty
Artificial insemination	3	The relevant welfare consequences resulting from feed withdrawal of toms before semen collection longer than 6 h are Prolonged hunger (certainty: 66%–100%) and Group stress (certainty: 66%–100%).	(1) More than 50% of breeder toms will experience Prolonged hunger after being deprived from feed for 6 h or more	66%–100%	
			(2) More than 50% of the breeder toms will experience Group stress after being deprived from feed for 6 h or more	66%–100%	
Feed restriction	1	The quantitative feed restriction applied to toms during the semen production period leads to the welfare consequence Prolonged hunger (> 50%–100%).	More than 50% of turkey breeder toms restricted to 80%–90% of ad libitum feed intake during the production period are expected to experience Prolonged hunger	> 50%–100%	Lack of evidence to link the current practice of quantitative feed restriction in turkey breeders to welfare consequence as described in this SO (such as Prolonged hunger)
	1	The feed restriction applied in toms during the semen production period leads to the welfare consequence Group stress (> 50% to 100%).	More than 50% of turkey breeder toms restricted to 80%–90% of ad libitum feed intake during the production period are expected to experience Group stress.	> 50% to 100%	Lack of data on the impact of quantitative feed restriction on competition for resources
Hatchery conditions	4	The hazard 'excessive noise' is present if the sound pressure level is 90 dB or above	More than 50% of birds housed with a noise level equal to or exceeding 90 dB will experience Sensory overstimulation.	> 50% to 100%	Lack of evidence from turkeys, it is extrapolated from day old chicks
	2	Newly-hatched poults subject to feed and water deprivation for longer than 48 h (from hatching to access to feed and water at placement on farm) experience Prolonged hunger and Prolonged thirst.	More than 50% of day-old poults feed and water deprived for more than 48 h will experience Prolonged hunger and Prolonged thirst	66%–100%	
Type and condition of the litter	5	The hazard 'too high humidity of the litter' is present when litter humidity exceeds 40% at any time during the rearing or production period	In more than 90% of the flocks the mean FPD score will be higher when litter moisture birds exceeds 40% for 3–5 days compared with flocks where litter moisture remains below 30%	90%–100%	

(Continued)

Chapter	Number	Conclusions	Uncertainty question: How certain are you regarding the statements below	Consensus judgement	Reason for low certainty
Type and availability of enrichment	6	To accommodate turkey breeder hens with an estimated body weight of 12 kg during the laying period, the minimum space allowance on elevated structures is 0.15 m ² /hen for 0.60 m wide platforms and 0.35 m/hen for the planks.	More than 90% of breeder hens are able to perch at night when 0.15 m ² /hen for 0.60 m wide platforms and 0.35 m/hen for the planks are provided	90%–100%	
	7	The EFSA experts consider the requirement of space allowance on elevated structures to be similar for hens kept for meat production.	More than 90% of fattening hens are able to perch at night when 0.15 m ² /hen for 0.60 m wide platforms and 0.35 m/hen for the planks is provided;	90%–100%	
	2	The relevant welfare consequences resulting from the hazards inappropriate, insufficient and absence of visual barriers are Group stress and Soft tissue lesions and integument damage (certainty: XX% -100%).	In more than 90% of the flocks, the proportion of turkeys experiencing Group stress and Soft tissue lesions and integument damage when housed with access to visual barriers such as hides or shelter compared to those housed without.	66%–100%	
	2 & 3	Inappropriate, insufficient and absence of a complex enriched environment with an outdoor range lead to increased Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Group stress, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation. The above-mentioned welfare consequences are experienced less by turkeys housed in a complex enriched environment with an outdoor range compared to turkeys housed without (certainty: XX% to 100%).	In > 90% of the flocks, the proportion of turkeys experiencing Group stress, Inability to perform exploratory or foraging behaviour, Inability to perform comfort behaviour, Soft tissue lesions and integument damage, Locomotory disorders (including lameness) and Sensory understimulation is reduced when housed with access to appropriate complex enrichment environment with an outdoor range compared with those housed indoors without complex enrichment environment and an outdoor range.	90%–100%	
Concentration of ammonia	2	The welfare consequences associated with the hazard 'too high ammonia concentration' <i>are prevented</i> , if the average 24-h ammonia concentration at bird head height is less than 10 ppm.	More than 90% of turkeys will not experience Respiratory disorders and Eye disorders when housed with an ammonia concentration of less than 10 ppm on average over 24 h at head height	66%–100%	
	3	The welfare consequences associated with the hazard 'too high ammonia concentration' <i>are present</i> , if the average 24-h ammonia concentration at bird head height is more than 25 ppm.	More than 5% of turkeys will experience Eye disorders and/or Respiratory disorders when housed with an ammonia concentration of 25 ppm or more on average over 24 h at head height	66%–100%	

(Continues)

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Chapter	Number	Conclusions	Uncertainty question: How certain are you regarding the statements below	Consensus judgement	Reason for low certainty
Concentration of CO ₂	2	The welfare consequence associated with the hazard 'too high CO ₂ concentration' is absent, if the average 24-h CO ₂ concentration at bird head height is less than 2000 ppm	More than 90% of turkeys will not to experience Respiratory disorders when housed with CO ₂ concentration of less than 2000 ppm over 24 h measured at head height	66%–100%	
	3	The welfare consequence associated with the hazard 'too high CO ₂ concentration' is present, if the average 24-h CO ₂ concentration at bird head height is more than 4000 ppm CO ₂	More than 5% of turkeys are expected to experience Respiratory disorders when housed with a CO ₂ concentration of 4000 ppm or more on average over 24 h measured at head height	66%–100%	
Effective environmental temperature	6	The use of elevated structures prevents and mitigates Heat stress.	In more than 90% of the flocks under the same housing conditions, the proportion of birds that experience Heat stress is higher when no elevated structures are present compared with when elevated structures are present.	66%–100%	

APPENDIX E

Public call for evidence – summary of evidence used

Instructions for accessing submissions from the Public call for evidence.

The submissions referenced in this SO are identified under the label 'EFSA Public call for evidence 2024', followed by the prefix 'PC-0741' which denotes the unique identifier of the Public call (PC) for evidence on the welfare of turkeys on farm. This prefix is further followed by a number indicating the specific topic of the call the submission refers to, alongside the name of the organisation that provided each submission.

The data provided by each stakeholder through the Public call for evidence is publicly available at the following webpage: <https://open.efsa.europa.eu/consultations/a0cTk00000024iflAA?search=turkey>.

The submissions specifically referenced in this SO are listed in [Table E.1](#).

- For submissions in the form of comments, open the webpage linked above and use the 'Download all comments' button to download all comments in a single file. Once downloaded, the relevant comment can be identified by searching for the corresponding Comment Number listed in the table.
- For submissions in the form of attachments, open the webpage linked above and use the PC ID and the organisation's name as listed in the table to locate the relevant submission. Additional details on where to find the attached file are provided in the 'Submission Location Details' column. These details can be retrieved on a page view displaying 20 results per page. If this column is left empty, it means that no file was attached to the submission.

TABLE E.1 Summary of submissions received in response to the EFSA Public call for evidence on the welfare of turkeys on farm, 2024 and cited in the present document.

Public call for evidence ID	Section of the public call for evidence	Stakeholders submitting information on turkeys farming practices	Comment number (in PDF comment document)	Attached file location on open EFSA link, if provided* ('20/page' view)
PC 0741	1 Husbandry systems of turkeys kept for meat production, turkey breeders, hatchery conditions, turkey poults and turkeys kept for meat production	Länsi-Kalkkuna Ltd	80	Page 5
PC 0741	4- environmental enrichment	Four Paws	17	Page 1
PC 0741	5- the practice of mutilations on turkeys	EFFAB	76	Page 4
PC 0741	3 space allowance in different husbandry systems	Compassion in World Farming Brussels (CIWF EU)	52	Page 3
PC 0741	3 space allowance in different husbandry systems	Länsi-Kalkkuna Ltd	82	Page 3
PC 0741	3 space allowance in different husbandry systems	Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung	30	Page 2
PC 0741	3 space allowance in different husbandry systems	Royal Society for the Protection of Animals (RSPCA) UK	40	Page 2
PC 0741	8 welfare assessment in turkey farming	Four Paws	19	Page 1
PC 0741	2 Breeding turkeys and impact on welfare	Four Paws	15	Page 2
PC 0741	5 The practice of mutilations on turkeys	Deutscher Tierschutzbund e.V.	49	Page 3
PC 0741	3 space allowance in different husbandry systems	Deutscher Tierschutzbund e.V	47	Page 3

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Public call for evidence ID	Section of the public call for evidence	Stakeholders submitting information on turkeys farming practices	Comment number (in PDF comment document)	Attached file location on open EFSA link, if provided* ('20/page' view)
PC 0741	3 space allowance in different husbandry systems	Landwirtschaftskammer Nordrhein-Westfalen	22	Page 2
PC 0741	3 space allowance in different husbandry systems	Djurens Rätt	57	Page 3
PC 0741	1 Husbandry systems of turkeys kept for turkey breeders, hatchery conditions, turkey poults and turkeys kept for meat production	Djurens Rätt	56	Page 1
PC 0741	2 Breeding turkeys and impact on welfare	Compassion in World Farming Brussels (CIWF EU)	52	Page 3
PC 0741	4 Environment conditions and environmental enrichment	Djurens Rätt	58	Page 3
PC 0741	1 Husbandry systems of turkeys kept for turkey breeders, hatchery conditions, turkey poults and turkeys kept for meat production	Institute for Animal Hygiene, Animal Welfare and Farm Animal Behaviour (ITTN), University of Veterinary Medicine Hannover	77	Page 4
PC 0741	1 Husbandry systems of turkeys kept for turkey breeders, hatchery conditions, turkey poults and turkeys kept for meat production	Dierenbescherming	3	Page 1
PC 0741	1 Husbandry systems of turkeys kept for turkey breeders, hatchery conditions, turkey poults and turkeys kept for meat production	Fachtierärztliche Praxis für Wirtschaftsgeflügel und Beratung	28	Page 2

*Not all the attachments provided were used in this SO but they are mentioned for completeness.

ANNEX A

Data extracted for the behavioural space model on planimetric data and time budget.

Annex A is available under the Supporting Information section on the online version of the scientific output.