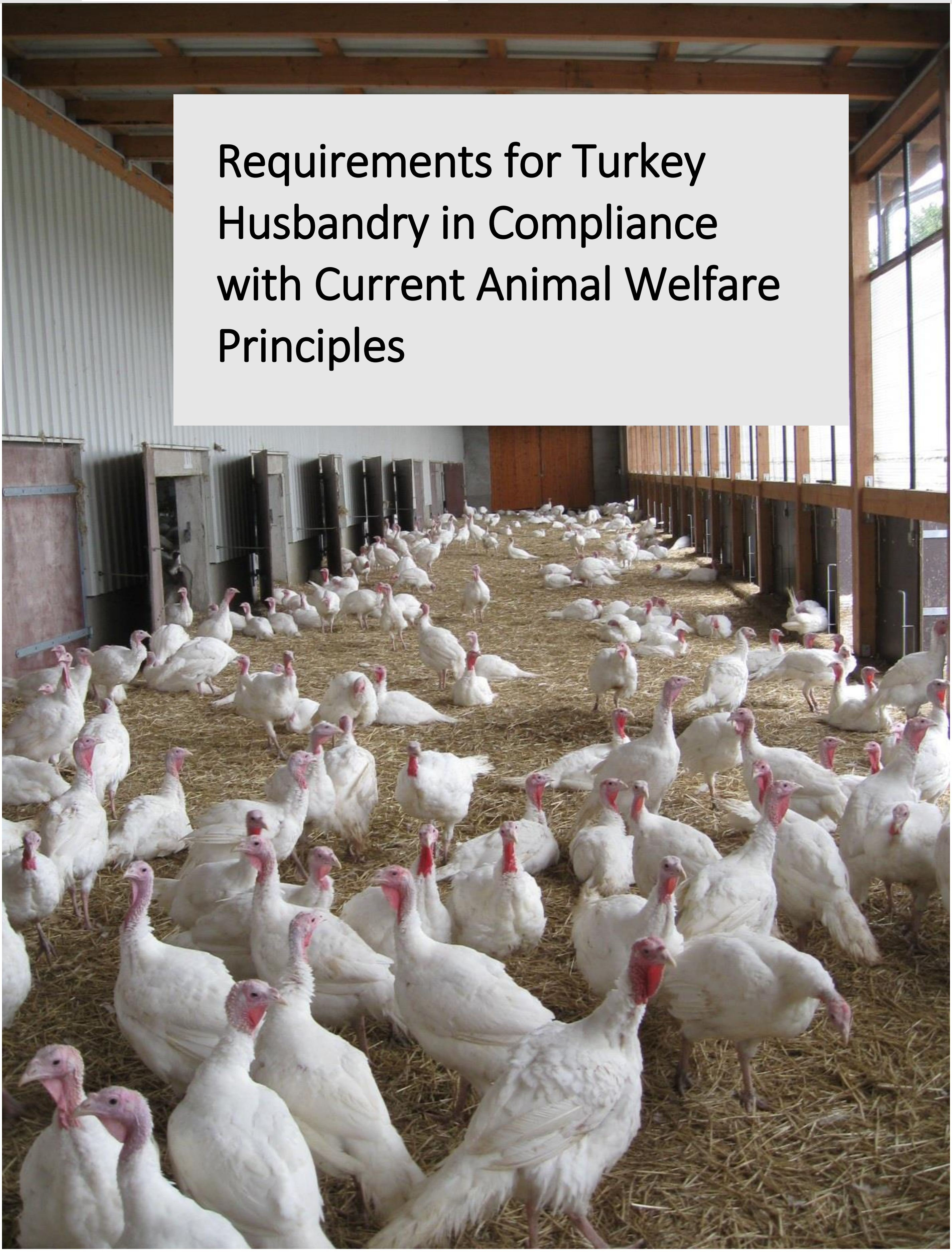
Bundesministerium
Soziales, Gesundheit, Pflege
und Konsumentenschutz

Requirements for Turkey Husbandry in Compliance with Current Animal Welfare Principles



Imprint

Media owner and publisher:
Bundesministerium für Soziales, Gesundheit, Pflege und Konsumentenschutz (BMSGPK)
[Federal Ministry of Social Affairs, Health, Care and Consumer Protection]
Stubenring 1, 1010 Vienna

Authors:
Prof. Dr. Maria-Elisabeth Krautwald-Junghanns
ML, Dipl. ECZM (avian), specialised veterinary,
European certified avian specialist

University of Leipzig
Faculty of Veterinary Medicine
University Veterinary Hospital
Clinic for Birds and Reptiles
An den Tierkliniken 17
04103 Leipzig

Tel.: +49 341 97-38400/-01
Fax: +49 341 97-38409
E-Mail: Krautwald@vogelklinik.uni-leipzig.de

Janja Širovnik Koščica
DVM, PhD
University of Veterinary Medicine, Vienna
Veterinärplatz 1
1210 Vienna

Tel.: +43 1 25077-4906
E-Mail: janja.sirovnik-koscica@vetmeduni.ac.at

Foreword

Under a contract dated 28 September 2020, we were commissioned by the Federal Ministry of Social Affairs, Health, Care and Consumer Protection of the Republic of Austria to prepare an expert report on the minimum animal welfare standards for turkey husbandry based on scientific findings.

Pursuant to the terms of the contract, the following expert report refers primarily to the constructional and personnel requirements of intensive husbandry of turkey fattening hybrids.

By reviewing the available scientific and technical literature mentioned below, drawing on our own expertise and professional experience as well as factoring in the physiological data of the turkey breeding lines currently used in turkey fattening, we have drawn up this expert report.

Leipzig, Vienna, 27 November 2020

M. Krautwald-Junghanns

Prof. Dr med. vet., ML,

Dipl. ECZM (avian)

Specialised veterinary

J. Širovnik Koščica

DVM, PhD

Note: This document is a translation of the study which was originally prepared in German language ("Anforderungen an eine zeitgemäße tierschutzkonforme Haltung von Mastputen"); June 2021.

Preliminary remarks on the literature research

In contrast to the breadth of scientific research on laying hen husbandry, current systematic scientific knowledge on the researched range of topics for turkeys is at this time available only to a very limited extent – if at all. This applies in particular to parent stock husbandry. Experiences with other poultry species are transferable only to a very limited extent, where at all possible. Many of the suggestions in this expert report can therefore be assumed only as conclusions based on individual existing observations and investigations.

The expert report focuses primarily on:

- citable primary scientific literature;
- dissertations that have been reviewed by several scientists;
- studies by scientific institutions usually commissioned by ministries / research communities;
- texts from conference reports that were based on scientific research.

In sections 1 and 2 in particular, it was moreover necessary to draw on unverifiable information from reference books, industry and internet research. Recommendations from expert committees were also included in the expert report.

The search engines Pubmed, Google Scholar and ResearchGate in particular were used for literature research.

In German-speaking countries, scientific research projects (often final reports for ministries) and dissertations could also be accessed thanks to the authors' activities in various committees.

Table of Contents

1 General preliminary remarks

Optimised husbandry conditions can compensate only to a limited extent for breeding-related negative effects on behaviour and animal health (due to unbalanced breeding to maximise the fattening performance). For example, the effects of high-performance breeding of fattening turkeys have a clear impact on animal health (e.g. high levels of foot pad dermatitis) and thus on the behaviour of the animals. These can be offset only to a limited extent with an improvement in husbandry conditions. Animal welfare legislation should therefore aim at reversing extreme performance breeding in turkey fattening in addition to husbandry conditions that are for appropriate for the species.

Turkeys can be kept and fattened in different ways. However, at present it appears to be more feasible for smaller flocks to implement exclusively extensive husbandry. Below, we will focus on intensive fattening systems, which are currently the main systems used in turkey fattening. A change away from purely indoor husbandry to extensive husbandry should also be aimed at for large commercial turkey flocks in the long term, however, through intensification of targeted research and in conjunction with breeding turkeys suitable for extensive husbandry.

1.1 Behaviour of wild turkeys

In order to analyse and assess the exercise of natural behaviour, it is essential to look at the behaviour of wild turkeys. The extent to which individual behaviours of wild turkeys can be transferred to today's broiler hybrids is often unclear, however. Behavioural studies on the latter described in the literature (where available) are detailed in the individual sections of chapter 4.

Like other Galliformes, turkeys are light-active animals, i.e. their activities take place exclusively during the day. The wild turkey is a scratching bird and is used to running perseveringly. Wild turkeys thus often cover great distances during the day (Healy, 1992). Lewis (1963), for example, observed that wild turkey flocks covered up to six kilometres per day in winter. Wild turkeys also can fly and do so to cover short distances quickly or to reach elevated areas such as trees (Healy, 1992). Nevertheless, especially with advancing age and weight, according to Healy (1992), turkeys prefer to walk or run. According to

Bircher and Schlup (1991a), unlike in other Galliformes, the daily routine of turkeys is not structured and therefore does not show any particular rhythm.

Turkeys rest at night when it is dark (Bircher and Schlup, 1991a). To protect themselves from predators, wild turkeys seek out elevated areas such as trees in the evening to spend the night (Healy, 1992). Bircher and Schlup (1991a) list the following positions as resting behaviour: standing, lying and sitting. In the first weeks of life, turkey poults cannot yet reach elevated areas and seek shelter under the mother on the ground. At 14 days of age, however, they are already perching on low branches. As their plumage development progresses, poults use elevated levels more frequently until they are sleeping with adults in the flock at the latest by 6 weeks of age (Cathey et al., 2007). The share of resting periods in wild turkey poults is very low: up to 14% of the light day (Healy 1992). However, this is based on the observation of a few animals only.

Wild turkeys are omnivorous. Hurst (1992) specifies the diet of wild turkeys in a review in which he points out that the proportion of animal components in the first week of life is very high. Bircher and Schlup (1991a) assign the following behaviours to foraging: pecking, scratching, hunting insects, eating grass seed and drinking. The wild turkey chicks observed by Healy (1992) devoted 86-95% of the day to foraging.

Turkeys are social animals and show characteristic group dynamics throughout the year. In spring, the hens breed and with their young live together with some other broods/families (females and poults) until autumn. In autumn, sibling groups of male turkeys form, while females congregate in larger flocks regardless of kinship (Watts and Stokes, 1971; Healy, 1992; Cathey et al., 2007). On wintering grounds, wild turkeys remain in sex-segregated groups and do not come together for courtship and mating until late February (Watts and Stokes, 1971). Turkeys morphologically similar to wild turkeys in a farmer's breed show the following actions of social behaviour: blushing, paling, pecking at conspecifics, parallel striding, mutual chasing and fleeing from each other, as well as impersonating, hacking, jumping at and "grabbing" each other in combative disputes. Submissive behaviours are head-pulling, "pushing under", submitting, dodging and ducking (Bircher and Schlup, 1991a).

Healy (1992) includes turkeys in the group of "ranking birds" as opposed to "territorial birds". The position of an animal in the ranking order here is the focus in the confrontation with conspecifics. Watts and Stokes (1971) describe how wild turkeys establish this ranking in various ways through fighting in autumn. These rank fights take place within male sibling groups, with other male groups and within hen flocks. There is no fighting between males and females. Watts and Stokes (1971) state that fights between two animals often last longer than two hours. In the rank fights, they each try to grab the snood or other skin areas of the opponent's head with their beak and thus pull the head down. According to Engelmann (1978), the first fierce fights can be observed from the 3rd month of life onwards and intensify until they reach their climax in the 5th month.

Wild turkeys are not sexually mature until they are 1 year old. According to Reiter (2009), the various behaviours in the afore-described imposition occur more frequently from sexual maturity onwards. However, tail-spreading and fluffing up can be observed in turkeys already after a few days of life (Le Bris, 2005).

1.2 Crossbreeding and modern hybrids

With the introduction of crossbreeding in the 1960s, traits of several specialised turkey lines were passed on to the next generation through hybridisation (Marks, 2017). For example, the body mass of turkey toms has quadrupled compared to a wild turkey (Hünigen et al., 2016). The most important highly specialised breeding companies operating worldwide are: the Erich Wesjohann Group based in Germany (Aviagen Turkeys) with the B.U.T. and Nicholas lines, and Hendrix Genetics based in the Netherlands (Hybrid Turkeys) with the Converter and Grademaker lines. The aforementioned lines result from intensive cross-breeding programmes, are fast-growing (medium to heavy) and are primarily marketed or processed in cut-up form (Olschewsky, 2019).

A growing body of scientific evidence suggests that intensive selection for increased growth potential and pectoral muscle ratio is associated with a greater incidence of growth-related myopathies and abnormalities (Zampiga et al., 2020). The aforementioned breeding companies also offer less fast-growing turkey lines, however, such as various lines from Aviagen Turkeys (Hockenhull Turkeys). Hendrix Genetics and the smaller breeding company Kelly Turkeys in the United Kingdom also offer various slow-growing hybrids suitable for free-range production (Kelly Turkey Farms).

In addition to the turkey lines currently in use, there is a large number of different turkey breeds from regional breeding initiatives in the USA and in European countries such as Austria, the United Kingdom, France and Germany.

Organic farming uses predominantly high-performance turkey breeds, too.

Apart from some studies on the slower growing bronze turkey Kelly BBB (Le Bris, 2005; Bergmann, 2006; Strassmeier, 2007; Schweizer, 2009; Bellof et al., 2014), there are hardly any data on the suitability of alternative breeding lines for organic husbandry conditions. In her doctoral thesis, Olschewsky (2019) investigated the suitability of the two slower-growing lines Hockenhull Bronze and Hockenhull Black in comparison with the reference Kelly BBB as to their suitability for organic husbandry conditions. The results showed few differences between the breeding lines, with all animals showing good performance and meat quality with comparatively few behavioural and health problems.

Taskin et al (2018) studied white and bronze turkeys (specific line not known) kept under identical conditions for 23 weeks as of 32 weeks of age. Their results showed that bronze turkeys had a better movement score and lower mortality rate compared with white turkeys.

McCrea et al (2012) compared the performance of traditional (Bourbon Red, BR) and conventional (Broad Breasted White, BBW) turkeys in an outdoor range management system until 17 weeks of age. Cumulative body mass gain, feed intake, feed conversion and foot pad health were compared at 7, 10, 13 and 17 weeks of age. The BBW turkeys had higher feed intake, weight gain, live weights, carcass weights and carcass yields than the BR turkeys. The majority of the BBW turkeys (75.2%) had developed detectable foot pad dermatitis by week 17, however. In contrast, the BR turkeys did not show any lesions here.

1.2.1 Influence of genetics on behaviour

Bircher and Schlup (1991a, b) found, apart from morphological differences (body growth and plumage condition), clear differences in behaviour (especially in activity) of turkeys from a farmer's breed (morphologically similar to wild turkeys) compared to Big 6 fattening turkeys under extensive conditions. In the case of Big 6 fattening turkeys, these included in particular longer lying times and reduced activity, especially of behaviours that are normally performed while standing. The activity in the fattening turkey lines used was also influenced by the housing conditions and the season (Bircher & Schlup, 1991b).

Erasmus (2018) describes that the behaviours defined as fear differed between the individual genetics at 20 weeks of age. This could also be misinterpreted, however, as the heavier origins could not run as fast as the lighter origins, for instance.

However, the use of lighter "alternative breeds" does not automatically result in improved foot health (Bartels et al., 2020a). Field studies on such alternative breeds document a high proportion of animals with foot pad lesions. Although in studies by Olschewsky (2019) Kelly-BBB turkeys had a higher live weight than animals from "alternative" turkey origins during the fattening phase, Kelly-BBB turkeys were less frequently affected than Hockenhull Bronze (up to 60%) and Hockenhull Black (up to 72%), with up to 39% necrosis on the sole surfaces. Dalton et al. (2016) were also unable to determine a correlation between different live weights and leg health in a commercial turkey line (name of line not indicated).

Genetics also influences the quality and duration of comfort behaviour. Bircher & Schlup (1991b) showed that farmer’s flock performed comfort behaviour on average 17-30% of the light day, while only 7-21% was recorded for Big 6 turkeys. In the Big 6 turkeys, the proportion of comfort behaviour while standing decreased during the fattening period compared with the farmer’s flock. At the same time, the plumage of the Big 6 turkeys was more soiled than that of the farmer’s flock, possibly because the Big 6 turkeys were less able to reach various parts of the body (e.g. the breast) due to the enlarged body (Bircher & Schlup, 1991b).

Bircher & Schlup (1991b) also reported that foraging was more pronounced in the slow-growing birds with 26-70%, over the whole day, than in the fast-growing Big 6 turkeys with 13-48%. In contrast, Berk et al. (2013b) found no significant influence of genetics on the rate of use of feeding and watering facilities for organically reared turkey hens and toms of Big 6 and Grelier Bronzés medium-weight lines.

There are different data for the onset of sexual maturity in domesticated turkeys. Engelmann (1978) had put sexual maturity at about the 30th week of life. Years later, Reiter (2009) describes the 19th week of life as the start of sexual maturity.

Conspecific (injurious) pecking is described as the most important behavioural disorder in turkeys, which must be distinguished from the described rank fights specific to the species that occur in wild turkeys and domesticated relatives. Injuries can also occur during these fights, but they are usually mild according to Healy (1992).

Le Bris (2005) found an influence of genetics on imposition behaviour, as Kelly BBB showed significantly more imposition behaviour than Big 6. Bergmann (2006), on the other hand, observed no significant difference in the imposition behaviour, pecking actions and fighting behaviour between Big 6 and Kelly BBB toms.

Große Liesner (2007) found a significant influence of genetics in the conventionally reared, debeaked turkeys studied, in that the heaviest line was most affected by injuries. In Strassmeier (2007), the Kelly BBB turkeys tended to be rated better than the Big 6 turkeys in terms of injurious pecking. In this context, Krautwald-Junghanns et al. (2009 a, b, 2017) found no influence of sex on the prevalence of injuries in conventionally reared, fast and slower growing turkey lines.

The use of slower-growing genetics also showed mostly advantages, such as a lower proportion of injuries (Olschewsky, 2019). The studies by Bergmann (2006) and Strassmeier (2007) also showed a significant influence of origin on plumage damage and injuries.

The conventionally reared, debeaked turkey hens and toms studied by Krautwald-Junghanns et al. (2009 a, b) had an average of 23% injuries of varying age and severity at the 16th week of life. In contrast, Krautwald-Junghanns et al. (2017) recorded very low injury rates of around 3% at the end of brooding and around 7% at the end of fattening in organically reared turkeys.

1.3 Turkey parent stock (cf. Annex 1 for further details)

There is almost no scientific literature on the husbandry of turkey parent stock. Scientific studies can be found only on the use of perches in parent turkeys (for instance Marks, 2017). The findings obtained there are reflected in section 4.2 Barn structure/perching options.

In addition to the lack of concrete studies on the species-appropriate husbandry of these animals, it is remarkable that little literature could be found on problems frequently described in fattening turkeys, such as behavioural disorders and foot pad dermatitis, in turkey parent stock. Research in this area is urgently needed.

The available literature is more engaged in increasing fertility in the parent hens, e.g. through feed restriction. In addition, numerous scientific studies deal with prophylaxis and therapy of diseases.

1.3.1 Animal welfare issues

Feed restriction: As turkeys are genetically bred for rapid growth, the parent stock quickly becomes obese. Feed restriction is consequently implemented, but this causes chronic hunger (Karcher and Mench, 2018). After two weeks of food restriction, turkeys responded with an increase in the heterophile/lymphocyte ratio, which may be an indicator of reduced welfare (Maxwell et al., 1992).

Animal welfare seems to be most negatively affected when turkeys are put on restrictive diets as early as 4 weeks of age. Hocking (1999a) studied behavioural and physiological differences between male and female turkeys fed ad libitum and turkeys on restrictive diets as of 4 weeks of age or as of 18 weeks of age (toms only). Turkeys whose feed had been restricted as of 4 weeks of age spent more time pecking walls and other objects in the environment. Turkeys on restricted diets as of 18 weeks of age spent more time preening (Hocking, 1999a).

On the other hand, high weight gain may be associated with health problems in breeding animals, which requires some feed restriction. Hocking (1999a) showed that plasma levels of lactate dehydrogenase, an enzyme associated with changes in tissue function and cellular damage, were lower in turkeys on restricted diets, which might be associated with a reduction in muscular and cardiovascular disease compared to turkeys fed ad libitum. Based on these results, Hocking (1999a) concluded that feed restriction of male turkeys after 18 weeks of age was associated with fewer negative effects on their welfare.

Movement restrictions: Even when feed is restricted, the parent flock is susceptible to the same musculoskeletal problems as their offspring (Karcher and Mench, 2018). The growth of fattening turkey hybrids has been increased to such an extent that they can no longer successfully mate naturally (Appleby, 2004).

Artificial insemination (for more details cf. Annex 1 b): Concerns about artificial insemination procedures for turkeys have often been raised (e.g. Karcher and Mench, 2018). To avoid contamination by urates and faeces during semen collection and artificial insemination, some farmers deprive the birds of feed for six hours before the procedure.

Behaviour: Karcher and Mench (2018) raised concerns about aggression in mixed-sex flocks and other social behavioural changes (feather pecking, cannibalism), and ensuing mutilations (debeaking).

Turkeys are sensitive to high ambient temperatures. Adding 1% arginine the diet contributed to a significant improvement in turkey welfare at high ambient temperatures (Glatz and Rodda, 2013). The addition of 1% arginine resulted in more frequent dust bathing, improved egg laying and reduced aggression among the birds (Bozakova et al., 2009).

Turkey hens tend to brood and want to stay on the eggs in the nest. This can lead to the hen no longer laying eggs. To prevent this, the hens are sometimes denied access to the nesting area (VKM, 2016).

2 Legal bases (cf. Annex 2 for further details)

There is no directive at EU level that regulates specific minimum requirements for the keeping of turkeys. Only Directive 98/58/EC of 20 July 1998 "concerning the protection of animals kept for farming purposes" applies.[1]

The study entitled "Animal Welfare in the European Union" by the Directorate-General for Internal Policies (2017) therefore concludes: "The poor welfare of turkeys is not prevented by any EU legislation. If there is no new no EU legislation on animal welfare, given the weak way in which Directive 98/58 is interpreted ...... turkeys ... etc. …will not be protected for most of their lives in much of the EU."[2]

2.1 EU law

General provisions

Directive 98/58/EC lays down general animal welfare requirements derived from the EU's acceptance of the European Convention for the Protection of Animals Kept for Farming Purposes (Council of Europe Convention). This Convention contains recommendations for individual categories of animals which Member States should apply.[3]

Specific recommendations

In June 2001, the Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes (on which Directive 98/58 is based) adopted a specific

[1] https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:01998L0058-20191214&qid=1587479205255&from=DE

[2] Directorate-General for Internal Policies: Animal Welfare in the European Union (2017). https://www.europarl.europa.eu/RegData/etudes/STUD/2017/583114/IPOL_STU(2017)583114_EN.pdf

[3] Report from the Commission to the Council on the experience acquired on the implementation of Directive 98/58/EC on the protection of animals kept for farming purposes, COM/2006/0838 final https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=COM:2006:0838:FIN

recommendation concerning turkeys,[4] which is general however and contains many facultative provisions.

Pursuant to Article 11, the design, construction and maintenance of enclosures, buildings and equipment for turkeys shall be such that they:

- allow the fulfilment of essential biological needs of turkeys, including the maintenance of good health;
- avoid barren environments;
- permit the birds to be kept in a level of light which does not impair normal behaviour and physiological function;
- do not cause traumatic injuries to the birds;
- limit the risk of disease and disorders manifested by behavioural changes;
- allow, without difficulty, a thorough inspection and facilitate the management of the birds;
- allow for easy maintenance of good conditions of hygiene and air quality and ensure thermal comfort for the birds at all ages, in particular during hot periods to avoid heat stress;
- provide protection from predators and from adverse weather conditions;
- avoid sharp corners, projections and materials which may be harmful to the birds;
- allow the prevention and treatment of internal and external parasite infestations.

Efforts must be made to provide turkeys with adequate facilities to enable them to engage in the various behaviours described under 'biological characteristics'. In particular, materials and objects – such as straw bales and elevated perches – shall be provided that encourage activities and exploratory behaviour, reduce injury-causing behaviour and allow the animals to escape from aggressors.

2.2 Examples of the legal situation in EU Member States

Binding specific regulations for turkey husbandry are in force only in a few Member States.

[4] https://www.verbrauchergesundheit.gv.at/tiere/recht/eu/EU-HaltungPuten.pdf?63xzlm

In **Austria**, detailed provisions on turkey husbandry are regulated in the 1. Tierhaltungsverordnung (1st Animal Husbandry Act)[5] which, in addition to general provisions for poultry, includes special husbandry requirements for turkeys. For example, elevated areas of 10% of the floor space maximum may be counted as usable area. Turkeys must have permanent access to dry, loose litter. The maximum stocking density for turkeys is 40 kg/m². Where outdoor access is provided, the minimum outdoor area is 10 m²/animal.

The keeping of fattening turkeys is not specifically regulated by law in **Germany**, apart from the general requirements in the Animal Welfare Act and the Animal Welfare – Farm Animal Husbandry Ordinance. With regard to the keeping of turkeys, only the *"Bundeseinheitliche Eckwerte für eine freiwillige Vereinbarung zur Haltung von Mastputen"* [German Voluntary Benchmarks for the Keeping of Turkeys for Fattening Purposes][6] were adopted at national level in April 2013 on the basis of an older benchmark agreement (from 1999). This is a voluntary commitment by the turkey industry, which has so far only been adopted at the political level by Lower Saxony by decree.[7]

There are no specific regulations for the keeping of turkeys in **Italy**. The general regulations are laid down in the *Decreto Legislativo 26 Marzo 2001, n. 146* [Legislative Decree no. 146 of 26 March 2001] in accordance with Directive 98/58/EC.[8]

In **Poland**, there is a Decree of the Minister for Agriculture and Rural Development of 28 June 2010 on minimum conditions for the keeping of farm animal species other than those for which protection standards are laid down in European Union legislation[9]. In addition to a section with general requirements, this decree also lays down specific rules for turkey husbandry:

---

[5] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20003820

[6] http://www.lkclp.de/uploads/files/bundeseinheitliche_eckwerte_mastputen.pdf

[7] http://www.topagrar.com/news/Home-top-News-Putenmast-Meyer-fuehrt-Bundeseinheitliche-Eckwerte-per-Erlass-ein-1260244.html ; https://www.ml.niedersachsen.de/startseite/themen/tiergesundheit_tierschutz/tierschutzplan_niedersachsen_2011_2018/puten/puten-110863.html

[8] European Parliamentary Research Service, Request number: 105984, Requested for: Wiener Sarah Office, 4 August 2020

[9] Rozporządzenie Ministra Rolnictwa I Rozwoju Wsi z dnia 28 czerwca 2010 r w sprawie minimalnych warunków utrzymywania gatunków zwierząt gospodarskich innych niż te, dla których normy ochrony zostały określone w przepisach Unii Europejskiej.
https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20101160778

§ 19 (2): The maximum stocking density shall be 57 kg/m² for turkeys kept for meat production and 40 kg/m² for all other turkeys.

The **Spanish** Regulation 1084/2005 on the keeping of poultry for fattening also covers turkeys[10]. In Annex I (B) d it is stated that the Council of Europe Recommendation is to be applied to turkey husbandry, without setting out how to proceed in practice.

Denmark has its own regulation on the keeping of turkeys for fattening.[11] The more detailed provisions contained therein are set out in Annex 2.

The provisions of the **Swedish** Board of Agriculture contain general information for poultry, which will not be discussed here. Barns of turkey fatteners who participate in a control programme may be occupied in accordance with the control programme, but not more than 40 kg/m² for birds < 7 kg and not more than 45 kg/m² for birds > 7 kg. Fatteners who do not participate in a control programme must comply with a limit of 30 kg/m².[12] A control programme is a programme that has been developed to ensure good animal care and has been recognised by the Swedish Board of Agriculture.

[10] Real Decreto 1084/2005, de 16 de septiembre, de ordenación de la avicultura de carne. https://www.boe.es/buscar/act.php?id=BOE-A-2005-16092

[11] Lov om hold af slagtekalkuner (Lov nr 91 af 09/02/2011) [Keeping of Turkeys for Fattening Act [Act no. 91 of 09/02/2011). https://www.retsinformation.dk/eli/lta/2011/91

[12] Statens jordbruksverks föreskrifter och allmänna råd om fjäderfähållning inom lantbruket m.m. https://lagen.nu/sjvfs/2019:23

3 Catalogue of requirements

Generally, there are requirements when keeping animals concerning the

1. movement and social needs of the animals,
2. premises and facilities for housing, feeding and watering the animals,
3. lighting and climatic conditions in indoor areas for housing the animals,
4. care, including supervision, of the animals,
5. knowledge and skills of persons who keep, care or have the animals cared for, and proof thereof for commercial purposes.

3.1 Requirements for the movement and social needs of turkeys

- The stocking density must at all times be such that turkeys have sufficient unobstructed space to
  - stretch,
  - move around the premises,
  - turn around,
  - stand freely,
  - stretch their wings,
  - engage in social behaviour appropriate to their species, and
  - have free access to food and water.

- In principle, the stocking density should be reduced as it has a variety of impacts on animal behaviour and animal health. Based on the available scientific literature with regard to the above criteria and accounting for economic considerations, the maximum stocking density for turkeys at the end of the fattening period should not exceed 36-40 kg of live weight per m² of usable floor space. The usable space is the floor space available to the birds without restriction. The area under the troughs and drinkers may be included in the usable floor space if they are height-adjustable and the feeding and drinking equipment is always at the back height of the animals as of the 21st day of life with unhindered feed and water intake.

- In addition to the kg/m² requirement, the absolute number of animals per m² must also be considered. More hens/m² are kept than toms under the same kg/m² ratio, which has an impact on animal health. The number of animals/m² should therefore also be kept as low as possible. This number depends on the hybrid type used and the final bird weight.

- There are no reliable data on the ideal group size of today's fattening hybrids. Nevertheless, the group size should be kept as small as possible with a view to the criteria of species-appropriate behaviour and with regard to the development of diseases.

3.2 Requirements for premises and other facilities for turkeys and for the quality of feeding and drinking equipment

3.2.1 Building and barn configuration including feeding and drinking water systems

- The housing systems and their equipment must be such at all times that the birds do not suffer injuries from sharp edges, uneven surfaces or defective components of the housing equipment.

- Conventional turkey housing is usually with litter system in barns with daylight or, partly, in windowless barns. Alternative systems to the conventional structureless barns must be further developed for reasons of animal welfare so as to allow the birds to perform their species-specific behavioural patterns.

- The longitudinal axis of the barn should be at right angles to the main wind direction so as to allow for appropriate air exchange.

- Feed and drinking water should be provided in disinfected and subsequently cleaned feed/water facilities, which are easily accessible at all times and available in sufficient numbers. The minimum dimensions specified in the *Bundeseinheitliche Eckwerte* (2013) for feed/drinking water places for turkey fattening appear to be sufficient.

- The height of the feed and water containers must be adapted to the age of the animals.

- The exclusive feeding of uniformly structured feed and the lack of foraging does not sufficiently meet the occupational needs of the animals. Alternatives such as additional differently structured feed or relocation of such additional feed should be further investigated.

3.2.2 Structuring of the barn

- It is necessary to structure the barn by creating resting areas.

- It is recommended to create elevated perching options.

- Straw bales are recommended as pure structuring elements. The birds can sit on them, they offer visual protection in the barn compartment, and they are pecked at by the animals.

- Wide elevated levels are used more than narrow perches. A ramp has proven to be effective in facilitating access to the elevated areas, so that even heavy fattening turkeys can reach them.

- Elevated areas can be counted as usable areas up to 10% of the barn floor space.

- Furthermore, "visual barriers" could be used to section the space and thus reduce the size of the group; research in this area is still needed.

- At least one sick pen should be installed per barn, with a stocking density that must in any event be below the maximum total stocking density of the barn.

3.2.3 Outdoor-climate area / run area

- The outdoor-climate area should cover at least 20% of the usable floor space and be offered as of the 6th week of life.

- Littered and permanently accessible sections of the outdoor-climate area can be counted as usable area up to 50% of the barn floor space.

- The outdoor-climate area must be roofed and provided with a solid floor plate with litter. The open walls (mostly wire mesh) should be on the lee side.

- The "Recommendations for the establishment and operation of an outdoor-climate area for turkey fattening" of the NMELV [Lower Saxony Ministry for Food, Agriculture and Consumer Protection] (2019 a, Annex 2) appear to be sufficient in terms of the dimensions and number of outlet openings and doors for the animal keepers.

- Outdoor run areas are to be adapted to the respective local climatic conditions and the breed lines. The animals should be accustomed to the outdoor run area as early as possible.

- The risk of introducing infectious agents and of predators must be taken into account when keeping turkeys outdoors. The turkeys must be provided with a shelter for protection and floor contamination must be reduced, e.g. by rotating the outdoor run areas.

3.2.4 Litter

- The litter must be clearly loose, dry, clean, as dust-free as possible and of such quality as to allows the birds to scratch and peck.

- The litter must always be prevented from hardening and getting damp by re-littering or loosening. The proportion of litter in the layer with which the animals come into direct contact must always outweigh the proportion of faeces, for example.

- The litter humidity shall not exceed 30% in all areas of the barn at any time.

3.3 Lighting and indoor climate conditions required for housing turkeys

3.3.1 Lighting

- There must be sufficient homogenous light in all buildings during the day to enable the birds to see each other and their surroundings and to engage in a normal level of activity. When considering light intensity and daylight incidence, it must be taken into account that turkeys perceive light brightness much stronger than humans.

- The minimum illumination should be 10 lux at animal eye level. The light day must not be strongly restricted. In addition, a clear day/night rhythm has a positive effect on flock health. The night (dark) phase should be 8 hours. In open-front barns, however, light duration and intensity may vary with climatic and seasonal conditions.

- Where artificial lighting is used, switching on and off requires continuous twilight phases until the desired light intensity is reached. Emergency lighting of 0.5 lux during the dark phase can guard against panic reactions.

- Deviations from the lighting programme are permissible during the acclimatisation, brooding, and depopulation periods, or if indicated by a veterinarian.

- Since UVA sensitivity plays an important role in the birds' behaviour, which is largely guided by the visual sense, additional UVA-emitting light fixtures should be fitted when UV-filtered daylight, or artificial lighting that does not emit a UVA spectrum is used.

- The lighting must be flicker-free, i.e. the frequency at which the light sources operate must be higher than the flicker fusion frequency observed in turkeys.

3.3.2 Indoor climate

- A good barn climate is important for animal welfare. Ventilation, dust, temperature, humidity and gas concentrations should be kept at levels that do not harm the birds. Their basic needs, some of which are age-dependent, must be taken into account. To assess welfare, it is always important to obtain feedback through constant observation of animal behaviour.

- As turkeys have high fresh air requirements, good air circulation is necessary throughout the barn. The ventilation of the barn should be controlled automatically, whereby the desired barn temperature can be precisely maintained via a thermostatically controllable system. Sufficient air exchange appears to be achieved at an air exchange rate of 5-7 m^3/kg/hour, or 4 m^3/kg/hour for young animals. Draughts must be avoided.

- The dust and noxious gas concentrations should be kept as low as possible. There are different recommendations for individual parameters (NH_3, CO, CO_2, H_2S). Inhalable dust should not exceed 3.4 mg/m^2; respirable dust should not exceed 1.7 mg/m^2. A maximum level of 10 ppm, 3000 ppm, and 5 ppm should not be exceeded for ammonia, CO_2 and H_2S respectively.

- Humidity in the barn should be between 50% and 70%. Turkey poults initially require high room temperatures of about 35-37 °C for the first week of life, followed by a gradual reduction to 22 °C until the 5th week and then to about 16-17 °C until final fattening. Sudden high temperatures cannot be compensated for by turkeys, so a good ventilation system is particularly important on hot days.

- An emergency power generator is necessary for all supply systems run on electricity, and an alarm system is required for electrically operated ventilation systems to report the failure of the ventilation to the person responsible for the animals. The alarm systems and emergency power generator must be checked regularly to make sure they are operating properly.

3.4 Requirements for care including the monitoring of turkeys

- All measures should be applied from hatching onwards by trained personnel in accordance with animal welfare requirements. Several daily checks of the animals in care (at least once in the morning and once in the afternoon in the case of debeaked turkeys and 3-4 times throughout the day in the case of intensively kept turkeys with intact beaks) are essential in all phases of life. Weak or sick animals must be moved immediately to a separate sick pen, treated or killed in accordance with animal welfare requirements, and dead animals must be disposed of as quickly as possible.

- Regular records should be kept on the monitoring of the animals and on the number of animals in the barn or in the sick pen, to be submitted to the supervising veterinarian / the competent authority upon request.

- The health of the animals must be checked at regular intervals (at least monthly) by the attending veterinarian and a record thereof must be duly kept.

- In order to counter the lack of stimuli in the environment, activity opportunities should be offered throughout the whole fattening period. The type of enrichments can be chosen freely, but they must be offered in sufficient numbers and in rotation. The equipment used for the activities must not lead to any adverse health effects on the animals. Activities that the turkeys have to "work out" themselves are well accepted. Straw bales and pecking blocks have proven to be particularly effective.

3.5 Knowledge and skill requirements for people who keep, care for or have to attend to turkeys

- All people in contact with the animals must have demonstrable knowledge and skills in handling the animals in their care appropriately.

- The animal keeper himself must have demonstrable agricultural or animal husbandry training with specific knowledge of poultry management. All people who look after the animals should attend appropriate short courses at least once or twice a year; certificates of the courses attended must be provided.

- The training must be extended to include various aspects relevant to animal welfare. Any final examinations should include animal welfare aspects as new material relevant to the examination.

4 Comments on the requirements under Point 3

4.1 Justification of the movement requirements and community needs of turkeys

Wild turkeys roam daily within a radius of several kilometres in search of food. The turkey is a bird that is used to running very fast and with great endurance. Even domesticated turkeys still like to run a lot on large pastures. In intensive husbandry, due to the strong weight gain of fattening turkeys, they now have to lie down for longer and longer periods of time as they mature (Bircher et al., 1991 b). The long resting periods and short activity periods during the light day, which are untypical not only for turkeys but for birds in general, are partly caused by the monotonous environment, which offers little incentive for activity. Cf. Sections 1.1 and 4.2 (resting behaviour/movement activities of the animals).

4.1.1 General preliminary remarks on stocking density

In poultry fattening, stocking density has a decisive influence on profitability and on the health and welfare of the animals (Buchwalder and Huber-Eicher, 2004). According to the Recommendation Concerning Turkeys (2001), the Standing Committee of the European Convention on the Protection of Animals kept for Farming Purposes is “aware that welfare problems arise when birds are overstocked and that this needs to be addressed as a matter of urgency.”

There are many scientific studies on the positive effects of lower stocking densities. Several authors have shown negative effects of high stocking densities, especially from the 12^{th} week of life. With increased stocking density, the animals are at greater risk of being disturbed by conspecifics in their resting behaviour. It is also known that high stocking densities can lead to poor body mass gain, poor plumage condition, increased foot disease, breast abscesses, air sac inflammation and increased mortality, whereas low stocking densities can have a positive effect. This will be explained in more detail below.

Stocking density is only one aspect within the complex husbandry requirements necessary for animal health according to current knowledge, however. Said requirements are also determined by parameters such as breeding targets, group size, housing temperature, ventilation, light quality, illuminance and husbandry management. One problem of high stocking densities, for instance, consists of excessively moist litter conditions, which require daily re-littering and good ventilation when the maximum density is reached in the middle and final fattening phases.

The effects of different stocking densities are consequently not fully comparable and uniform in scientific studies which vary in other husbandry parameters.

4.1.2 Recommendations / Guidelines

As already mentioned, recommendations and trials on stocking density for turkeys in the literature are often difficult to classify in terms of their comparability; the kg/m² ratio appears to be the most appropriate measure, although it is also important here to take into account the number of animals/m² (see under stocking density and foot-pad dermatitis). If only the number of animals/m² is given in the literature however (without indication of age, breed used, etc.), a comparison of stocking densities is not possible. This applies in particular to older sources, as the fattening capacity of turkeys has increased considerably in the meantime.

Various guidelines on the maximum stocking density have been developed as a consensus of different subjective opinions. The maximum stocking densities in Austria and Switzerland of 40 kg/m² and 36.5 kg/m² respectively are below the European average. The UK Department for Environment Food and Rural Affairs recommends 38.5 kg/m² (DEFRA, 2019). In Germany, there are various programmes (Bundeseinheitliche Eckwerte [Voluntary Benchmarks], Tierwohlkontrollprogramm [animal welfare control programme]) which provide for different stocking densities. For example, the recommendations of the Federal Ministry of Food, Agriculture and Consumer Protection and the German state of Lower Saxony specify maximum stocking densities for turkey hens of up to 45 kg live weight/m² of usable floor space and for turkey toms of up to 50 kg/m² of usable floor space. American stocking density standards and recommendations for turkeys vary significantly and range from 5.9 kg/m² to 73.2 kg/m² (Erasmus, 2017).

In contrast, the German Animal Welfare Association *Deutscher Tierschutzbund e.V.* [German Animal Welfare Association] calls for maximum stocking densities of 1 to 2 animals/m², which would correspond to a stocking density of 21 to 42 kg/m² for toms with a live weight of 21 kg.

The Royal Society for the Prevention of Cruelty to Animals (RSPCA) recommends that the stocking density should never exceed 25 kg/m² (RSPCA Welfare Standards for Turkeys, 2017).

For organic turkey farming, the stocking density must not exceed 10 birds/m² or 21 kg/m² (EU, 2018).

Examples of stocking densities in European countries:

Country	**Stocking density (kg/m²)**	**Legal provision?**
Austria	**40**	**yes**
Switzerland	**36.5**	**yes**
United Kingdom	**38.5**	**no**
France	**No specific requirements**	**no**
Germany	**45 (hens) –** **50 (toms) ✶**	**no**
Norway	**44 (for birds >7 kg)**	**no**
Denmark	**52 (hens) – 58 (toms)**	**yes**
Sweden	**30 ✶**	**yes**
Finland	**No specific requirements**	**no**

✶ Higher stocking densities are permitted if farmers follow special programmes, e.g. federal benchmarks in Germany.

4.1.3 Experiments to calculate space requirements for fattening turkeys

There is currently no scientific research on the exact amount of space a turkey needs to exercise normal behaviour. In addition to undisturbed resting behaviour, the animals should for instance be able to move freely, have the opportunity to exercise normal behaviour and have free access to feed and water.

The formula for animal space requirements A (m^2) = k x W 2/3 (kg), where A = floor space per animal, k = coefficient, W = live weight, issued by the UK Farm Animal Welfare Council (FAWC) in 1995, resulted in high stocking densities for British fattening turkeys. However, the UK Department for Environment Food and Rural Affairs recommends a stocking density of 38.5 kg/m^2 (DEFRA, 2019).

Most of the other methods used to determine the space requirements of animals have been obtained from caged laying hens and are not applicable to turkeys.

Planimetry is the measurement of the space requirements of an animal based on the space covered by the body. For example, according to planimetric studies by Graue et al. (2013), a turkey tom with a final fattening weight of 18-21 kg covers an area of approximately 1,600 cm^2 to 1,700 cm^2. Kulke et al. (2017) used contrast-based planimetry (KobaPlan) to determine how much floor space a turkey tom of the B.U.T. 6 line covers at different times during rearing and fattening in standing and sitting postures. To that end, 500 birds were weighed and photographed in a wooden crate in both standing and sitting postures. Subsequently, the area of the imaged animals was determined using the computer software “KobaPlan”. On the 35th day of life towards the end of the rearing phase, the animals weighed on average 1 975 g and covered between 377.2 cm^2 (standing) and 414.4 cm^2 (sitting) of the barn floor area. Based on these values and in accordance with existing regulations for the stocking density in finishing fattening, the authors recommend a maximum stocking density of 11 birds per m^2 of floor space. On the 133rd day of life, turkeys with an average live weight of 21 139 g occupied 1 405.0 cm^2 in standing posture and 1 622.2 cm^2 in sitting posture. With a maximum stocking density of 58 kg live weight/m^2, up to 44.45% of the barn floor space was covered by the animals, depending on their posture. Further ethological studies are necessary however in order to determine the extent to which the tested stocking densities meet the needs of the animals in the end.

Ellerbrock et al. (2002) used planimetry to measure the area filled by Big 6 fattening turkeys in the experiment: with a stocking density of 2 toms/m², 35% of the available area was covered at the 19^{th} week of life; with 2.7 birds/m² already 47%, and with 3.5 birds/m², 61%. Their investigations clearly showed that this strong difference in area had a clear effect on the behaviour of the animals.

However, planimetry does not take into account space requirements for movement, social interactions and other behaviours. Scientific values for the inclusion of such criteria (“behavioural space”, “social space”) could only be obtained through ethological studies.

4.1.4 Stocking density, group size and behaviour

Movement: Wild turkeys roam daily in search of food. The turkey is used to running very fast and with great endurance. With increasing stocking density in intensive farming, the mobility of the animals deteriorates, hip and foot lesions occur more frequently at the highest densities, and body weight decreases significantly with decreasing floor space/animal (Martrenchar et al., 1999b).

Social structure: Like all gallinaceous birds, turkeys live in structured social associations and show characteristic group dynamics over the year. Toms form their own age-specific groups throughout the year. In autumn, sibling groups of male turkeys form, while females congregate in larger flocks regardless of kinship (Watts and Stokes, 1971; Healy, 1992; Cathey et al., 2007). In the winter quarters, wild turkeys remain in sex-segregated groups and do not come together for courtship and mating until late February (Watts and Stokes, 1971). It is therefore necessary for the appropriate behaviour of species that appropriate social structures can develop. The current group size in intensive husbandry of several thousand animals in one room does not concur with this feature.

Buchwalder et al. (2005) were able to show with their experiments that the larger the group size, the more difficult it is for an individual to distinguish between the individual animals (the number of conspecifics that a gallinaceous bird can remember is limited; however, more precise data on this is only available for chickens). In today’s intensive turkey fattening, both the group size and the stocking density are greatly increased and the natural age structure is eliminated. As a result, the likelihood of social conflicts increases, and they are usually much more pronounced and intense in toms (Healy 1992). Bessei and Günther (2005) also studied male (2.5 birds/m², 3 birds/m², 3.5 birds/m²) and female (5 birds/m², 6 birds/m², 7 birds/m²) turkeys at different stocking densities and saw a significant increase in feather pecking at the high stocking density.

Bircher and Schlup (1995) also hypothesised that high group size and stocking density increase the likelihood of conflict situations, as the number of turkeys an animal can remember is limited and no fixed ranking can be established in large groups. According to Martrenchar et al. (1999b), in large groups of over 100 birds feather pecking is independent of group size due to the fact that a social hierarchy can no longer be established.

For example, it has been shown that it is possible to keep turkey toms at high light intensity (60 lux) without severe feather pecking if the group size and stocking density are low (birds kept in pairs at a density of 0.2 birds/m²) (Sherwin and Kelland, 1998a).

Resting behaviour: Turkeys need to rest and sleep to maintain their normal biological function. Open unstructured systems mean that birds are frequently disturbed by other birds. Due to the group size of up to 400 chicks per ring in ring-rearing systems, the resting behaviour of intensively kept turkey poults is negatively altered in the first weeks of life compared with the extensively kept ones. The former hardly come to rest because the lying birds are repeatedly disturbed by the more active conspecifics (Dillier, 1991). The extent to which this could have an effect on later behavioural disorders can only be conjectured.

Similarly, resting behaviour in male and female turkeys kept separately by sex was increasingly disturbed with increasing density (Martrenchar et al., 1999b).

As aforementioned, Bessei and Günther (2005) studied male (2.5 birds/m², 3 birds/m², 3.5 birds/m²) and female (5 birds/m², 6 birds/m², 7 birds/m²) fattening turkeys at different stocking densities and saw significant increases in sitting/lying/grooming at the low stocking density. The authors explain this effect by the fact that the animals are less disturbed at lower stocking densities.

Opportunities of social avoidance (on the subject of barn structure, cf. 3.2 and 4.2): Turkeys need to be able to avoid and escape aggressive birds. A critical distance of 50 cm seems nonetheless to be sufficient to reduce the frequency of pecking at the head and neck of an unknown male BUT-9 tom (Buchwalder and Huber-Eicher, 2004). This escape or avoidance distance should be provided at all times in intensive husbandry.

In principle, in addition to a reduction in stocking density, a temporary (not permanent due to the high degree of mechanisation) subdivision of the house into groups of small sizes should be aimed for. The following studies provide concrete examples: Using 120 cm x 30 cm wide plywood boards as visual barriers in the barn (as well as additional UV light for the length of the photoperiod and straw supplementation), the incidence of feather pecking was reduced very significantly in studies by Sherwin et al. (1999 b). However, further research is needed on this, as the preferred group size of current turkey hybrids is also unknown. Buchwalder et al. (2005) were able to show that a group size of 30 animals already seems to be above the limit at which a turkey can distinguish between individuals. The frequent occurrence of aggressive behaviour in commercial flocks however is not based on the aforementioned recognition of individuals. Small groups of wild and domesticated turkeys seem to form stable hierarchies (Healy 1992). The aggressive behaviour can therefore be seen more as an attempt to maintain a stable hierarchy (Buchwalder et al., 2005).

4.1.5 Stocking density and body mass / feed conversion ratio

It should be noted that many studies on this are older and were carried out with turkey lines that differ genetically from the animals used today in terms of growth rates and feed conversion.

In general, according to Erasmus (2017), lower body mass, reduced feed conversion and increased mortality rates are associated with stocking densities above 29.3 kg/m². Beaulac et al (2019), studied turkey toms under 4 different stocking densities: 30, 40, 50 and 60 kg/m². Body weight gain decreased with increasing stocking density. Feed consumption increased with increasing stocking density from week 4 to 8 and decreased with increasing stocking density from week 12 to 16. The authors concluded that increasing the stocking density resulted in poorer performance of turkey toms from week 16 of life. The data suggest that higher stocking density at a younger age is less of a concern as turkey toms are still likely to be able to move around and easily access food and water as floor space is not too restricted. As the bird becomes heavier with age, access to food and water may become more difficult due to reduced floor space and manoeuvring through many birds.

Kulke et al. (2014) studied fattening turkeys at two different stocking densities of 40 and 58 kg/m². With an expected average weight of 21 kg for the toms at the time of slaughter, this corresponds to 1.9 animals/m² and 2.8 animals/m² respectively. The area of the outdoor-climate area was taken into account at 50% when measuring the stocking density. In the first run, turkeys at a lower stocking density weighed up to 1100 g more than animals at a higher stocking density, both during manual weighing and at the slaughterhouse. In contrast, the live weights at the end of fattening determined in the second run by the automatic animal weighing and the slaughterhouse were about the same in both stocking densities and weight advantages of the lower over the higher stocking density only showed during manual weighing.

Hafez et al (2016) found better but not significantly higher weight gains at the lowest stocking density when comparing stocking densities of 25 kg/m², 48 kg/m² and 58 kg/m². Already in the past, Coleman and Leighton (1969) also recorded lower weight gains when stocking densities were increased above 46.7 kg/m².

The desired value in rearing is given as a maximum of 10 animals/m² (Kartzfehn, 2017), so the average stocking density in German rearing barns was 9.3 animals/m² on the 22nd-35th day of life (Krautwald-Junghanns et al., 2012).

4.1.6 Stocking density and injurious pecking

The term “cannibalism” is often used in the available literature, especially in older publications, which implies that the animals are killed or eaten by their conspecifics. This is usually not the case for turkeys, so it is more appropriate to speak of “injurious pecking”.

In addition to breeding (genetic component), unsuitable housing climate, unfavourable light conditions, excessive group size and lack of activity due to the barren, unstructured housing environment, excessive stocking density is repeatedly cited as the cause of injurious pecking.

In contrast to the inability of turkey hybrids used at that time to move around and clean their plumage properly, which Bircher et al. (1991b) attribute to breeding, injurious pecking is mainly caused by husbandry factors. Overcrowding, in conjunction with other factors, leads to feather pecking and cannibalism. Intensively kept turkeys (B.U.T. Big 6 fattening hybrids) showed injurious pecking of conspecifics far more frequently than extensively kept animals, in which it occurred only sporadically. This was attributed to the high stocking density in intensive husbandry. Due to the strong weight gain of the fattening turkeys, longer and longer lying periods were recorded with increasing age. However, the litter, which became soiled in the further course of the husbandry, offered less and less incentive for foraging and pecking. With increasing age, substrate pecking occurred more frequently in lying posture. The high stocking density led to the animals usually lying very close to each other. Besides the uninteresting litter, there were mostly only conspecifics that could be (ab)used as pecking objects within the reach of the beak (Bircher et al., 1991b). (Note: For this reason, changeable activity material (cf. under 4.2) in particular is being increasingly offered or is already prescribed in various welfare label programmes).

In alternative housing with access to grassland and halved stocking densities and group size, the latter formed the basis for the establishment of an intact social order, and injurious pecking was not observed among these animals (Feldhaus and Sieverding, 2001). In her dissertation, Strassmeier (2007) observed the behaviour of feather pecking experimentally with a very low stocking density and small group size with an outdoor run. No injurious pecking occurred, despite the fact that the beaks were intact. Therefore, in the author’s opinion, debeaking can be dispensed with if sufficient space is available in free-range systems. Display behaviour clearly outweighed the number of fights observed. Due to the given low stocking density, the animals were able to avoid each other and thus avoid aggressive interactions (Strassmeier, 2007).

The relationship between stocking density, environmental enrichment and the occurrence of cannibalism and feather pecking has been studied by a number of authors (Schlup et al. 1990; Bircher et al., 1996; Sherwin and Kelland, 1998a,b ; Crowe and Forbes, 1999; Martrenchar et al., 2001; Berk and Hinz, 2002; Cottin, 2004; Wartemann, 2005). Lower stocking densities, smaller group sizes and light appropriate to the species as well as suitable structuring of the turkey houses are repeatedly given as ways to prevent injurious pecking.

Sherwin and Kelland, 1998b, Martrenchar, 1999a, Ellerbrock, 2002, Buchwalder and Huber-Eicher, 2004, and Erasmus, 2017, among others, describe excessively high stocking density as a trigger for the frequent occurrence of aggressive pecking.

Kulke et al. (2014) studied fattening turkeys with two different stocking densities of 40 kg/m² and 58 kg/m². Once again, more turkeys needed to be separated due to fresh bloody skin lesions in the higher stocking densities than in the lower stocking densities of both runs.

The frequency of agonistic behaviour does not increase linearly with an increase in stocking density. The relationship is curvilinear. A possible explanation for this is the suppression of agonistic interactions between subdominant animals due to the proximity of dominant animals (Ellerbrock, 2002).

According to the authors, the low incidence of skin injuries in organic husbandry found in the experiment by Spindler et al. (2013 a, b) can possibly be attributed to the increased space available compared with conventional turkey husbandry, which allows animals to avoid pecking conspecifics.

This seems to be the case for small groups of turkeys also when new animals are introduced into them. Buchwalder and Huber-Eicher (2005) attribute this to the fact that a turkey can only distinguish between a limited number of conspecifics. But here, once again, the space available was a decisive factor: with less space, the turkey toms reacted more aggressively in the experiment than with more space (Buchwalder and Huber-Eicher 2004).

4.1.7 Stocking density and foot pad dermatitis

The results of a study in a slaughterhouse show a clear association between stocking density and the incidence of foot pad dermatitis (FPD) (Freihold et al., 2018). This is confirmed by other studies that also reported that higher stocking density is associated with a higher incidence of FPD (Noll et al., 1991, Martrenchar et al., 1999b, Martrenchar et al., 2001, Hafez et al., 2005, Erasmus, 2017). Furthermore, increased excrement load entails an increase in litter moisture, which is one of the significant factors for the development of FPD. Beaulac et al. (2019) found a squared effect for average litter moisture with increasing stocking density.

The different levels of prevalence between individual European countries for the occurrence of FPD are certainly due in part to different fattening weights and fattening durations in addition to different stocking densities. In Norway, for example, turkey hens are generally fattened for a much shorter period and with a lower final fattening weight than in Germany.

One aspect besides the absolute kilogramme/m² figures is therefore also the calculation of the number of animals/m². For example, Krautwald-Junghanns et al. (2011 a) and Ellerich (2012) found in their studies on fattening turkey flocks in Germany that the feet of female animals in the later fattening phases were in general affected by foot pad disorders twice as often (60%) as those of toms of the same age. Hafez et al. (2005) and Rudolf (2008) also obtained similar results. Krautwald-Junghanns et al. (2011a) and Ellerich (2012) explain differences related to sex with the higher amounts of fresh manure per given area in hens. At a stocking density of 52 kg/m² (approx. 4.8 hens/m²) or 58 kg/m² (approx. 2.8 toms/m²), there are significantly more hens than toms in a given area in the final fattening stage.

The results of studies in the slaughterhouse (Freihold et al., 2018) also showed that hens were more frequently and more severely affected by foot pad dermatitis than toms. Differences in the prevalence of FPD between the two sexes were again attributed to the number of birds/m².

4.1.8 Stocking density and plumage/skin disorders

Ellerbrock and Knierim (2002) studied turkey toms at three different stocking densities: 39 kg/m², 52 kg/m² and 67 kg/m². The birds in the lowest stocking density had significantly cleaner and more complete plumage and significantly fewer breast skin disorders. Berk and Hahn (2000) also reported that the incidence of breast skin abscesses was higher at 3.5 birds/m² than at 1.5 birds/m². However, Krautwald-Junghanns et al. (2009 a,b) could not see any clear correlations between high stocking density and increased number of breast blisters. On the contrary, the development of breast blisters was negatively correlated with stocking density. A possible explanation in the authors' view is that due to the high stocking densities in their study (> 52 kg/m²) and the associated crowding/disquietude in the barn, longer phases of resting and lying down were not possible for the animals during the day, thus preventing the formation of breast blisters.

4.1.9 Stocking density and skeletal diseases

Diseases of the skeletal system, known as “leg weakness”, can cause pain and suffering in turkeys. The cause of non-infectious leg weakness was in older literature attributed primarily to various influences of breeding, but to a lesser extent also to influences of feeding and husbandry, and in the latter case especially to litter quality and stocking density (Martrenchar et al., 1999b). Consequently, in addition to breeding selection and the optimisation of feed composition, preventive measures should aim at improving housing conditions so as to promote movement activity among the animals by reducing stocking density (Hafez, 1996).

Martrenchar et al. (1999b) could not see any influence of different stocking densities (5, 6.5, 8 turkeys/m²) on the walking activity of the animals. The gait pattern was nonetheless worse at the highest stocking density and the incidence of hip joint disorders was higher.

There have hardly been any publications on this subject in recent years. It can be assumed that as a result of selection measures at grandparent and parent level, the so-called “leg weakness complex” (e.g. tibial dyschondroplasia) plays a lesser role today (Hörning, 2017).

The effects of increased stocking density and heat stress on growth, feed conversion, carcass characteristics and skeletal system properties in turkeys were investigated by Jankowski et al. (2015). The animals were reared at a stocking density of 2.8 birds/m² at thermoneutral temperature (TnT group), while the experimental group (HSID group, 5° higher ambient temperature) was kept at a stocking density of 3.4 birds/m². The weight, length, volume, vertical and horizontal diameters, cross-sectional area, second moment of inertia, volumetric bone mineral density, maximum elastic strength and final bone strength were significantly lower ($P < 0.05$) in turkeys of the HSID group at 126 days of age compared to the TnT group. Further, the results showed that turkeys up to four weeks of age tolerated increased stocking density and heat stress better than birds between 5 and 18 weeks of age.

4.1.10 Stocking density and respiratory (stress) symptoms

Several authors have reported a higher incidence of air sac inflammation or lung disorders at higher stocking densities (Noll et al., 1991, Perkins et al., 1995). Perkins et al. (1995)

discuss that turkeys kept at higher stocking densities may experience greater stress levels that contribute to the development of respiratory disorders. From a veterinary perspective, their own experience also shows that higher stocking densities result in an increased accumulation of feather dust, which is conducive to respiratory diseases.

According to Erasmus (2017), turkeys kept at higher stocking densities are presumably also less able to cope with other environmental stressors such as increased temperatures ("heat stress").

4.1.11 Other

The purpose of another study by Hafez et al. (2016) was to determine the effect of stocking density on haematology, immune response and use of medication in turkey toms. Three different stocking densities were compared, namely 25 kg/m², 48 kg/m² and 58 kg/m². The results obtained showed that there were no specific differences in stocking density with respect to the parameters mentioned.

4.2 Comments on the requirements for animal housing facilities as well as for feeding and drinking equipment

4.2.1 Building and characteristics of the house incl. feeding and drinking systems

A housing system is considered to be animal-friendly if it offers the animals a richly designed environment with numerous choices. Conventional turkey husbandry is carried out in barns with daylight or partly in windowless barns. Generally, the houses have no structure except for feeding and watering systems, so that the exercise of behavioural patterns specific to the species is possible only to a limited extent if at all (Berk, 2002).

Alternative systems to the existing ones should be developed for reasons of animal welfare, health control and also environmental protection.

4.2.1.1 Feeding facilities

The clear expression of foraging and eating behaviour in wild turkeys shows how much these environmental conditions influence the ontogenesis of individual behaviour patterns. For example, certain experiences are withheld from intensively kept turkey poults from the outset, such as the harvesting of seeds or the experience that food is not concentrated in just one place (Dillier, 1991).

The turkey's diet is an important factor for animal health. Wild turkeys are not dietary specialists. They eat various plants (grass, acorns, seeds, leaves, bark from branches) and to a lesser extent animals (Hale et al., 1969). Domesticated animals also use a wide range of foods when offered. In addition, wild turkeys spend a large part of the day foraging. Feeding pellets alone does not adequately meet the animals' needs for activity. For example, Bronze turkeys required an average of 136 min to forage on meal feed, but only 16 min on pellets (Jensen et al., 1962). By comparison with the meal feeding, the tendency to injurious pecking therefore increased with pure pellet feeding, but the growth performance improved.

The lack of stimuli in intensive husbandry also becomes clear in the failure to take the two points mentioned (variety of food, foraging) into account. There are numerous approaches to the issue of feeding, but, as agreed, they were not evaluated for this report.

There is hardly any scientific evidence as to the trough side length meeting the requirement that it must be possible for all turkeys to eat simultaneously at all times. The minimum trough side length of 0.18 cm/kg live weight (0.8 cm usable trough side length/kg in rearing) indicated in this context for turkey fattening seems to be sufficient, nonetheless.

In tube feeders with a usual diameter of the troughs of ca. 30 to 50 cm, at least one trough per 250 kg live weight in the rearing phase or per 1000 kg live weight in the fattening phase must be available. In the case of individual feeders with a diameter of ca. 60 cm, at least one feeder should be available per 1500 kg live weight in the fattening phase (Bundeseinheitliche Eckwerte, 2013).

4.2.1.2 Drinking facilities

Drinking water should be offered in disinfected and then cleaned water troughs that are easily accessible and available in sufficient numbers. The height-adjustable drinking troughs must make it possible for the birds to drink from a free, clean water surface. The drinking facilities must therefore be adjusted so that all animals – also the weaker ones – can drink unhindered at all times and that the water spill into the litter remains as low as possible (ten Haaf, 1997). Daily cleaning of the drinking water containers and once (fattening) or twice (rearing) daily renewal of the drinking water are necessary, especially in the first days of life, and special attention should be paid to avoiding wet litter.

There is little scientific evidence as to the length of the trough that meets the requirement that it must be possible for all turkeys to drink at all times. The minimum trough side length of 0.10 cm/kg live weight (0.4 cm usable trough side length/kg in rearing), which is commonly used in practice, appears to be sufficient for turkey fattening, nonetheless.

The German Voluntary Benchmarks (2013) stipulate at least one nipple per 150 kg live weight in the rearing phase and per 500 kg live weight in the fattening phase as minimum values for drinking facilities with nipples and drinking bowl under the nipples. In the case of individual drinking troughs with a usual diameter of approx. 25 to 50 cm, there must be at least one per 350 kg live weight in the rearing phase and per 2000 kg live weight in the fattening phase.

4.2.2 Structuring of the barn

Conventional turkey barns do not contain any structural elements apart from the feeding and drinking facilities, even though these could have a variety of advantages for animal welfare (spatial separation of the exercise of natural behaviour, possibility of evasion, stimulation of locomotion ...) and are also increasingly discussed in conventional turkey husbandry, especially against the background of minimising injurious pecking. Such structural elements can come in various forms such as elevated levels, perches or straw bales. In addition, partitions can be used to structure the barn into different subgroups.

The effects of structural elements described in the literature often cannot be clearly classified or compared with each other. The positive effects outweigh the negative ones however, and it can be assumed that structural elements in the barn promote animal welfare.

4.2.2.1 Separated areas in the barn

Resting areas – general: Whereas wild turkeys clearly prefer resting in elevated places at night, resting during the day is not necessarily bound to such places. Wild turkeys are active mainly in the morning and evening hours. The time between these activity peaks is often spent resting (Marks, 2017). Bircher and Schlup (1992b) indicate that the proportions of resting behaviour (74.4% indoors vs. 73.6% with an outdoor run) and locomotor behaviour (8.3% indoors vs. 9.0% with an outdoor run) did not differ significantly among turkeys of the heavy type in conventional and free-range systems. Resting behaviour increased with age in both groups, regardless of the type of housing. Similar results were obtained by Noble et al. (1996), who compared the behaviour of four different turkey lines kept indoors and outdoors. The frequency and duration of locomotor functions hardly differed. As to resting behaviour, it was observed that the duration of resting was significantly longer in the outdoor area, while the number of resting phases was greater in the indoor area.

Open unstructured systems entail that the birds are frequently disturbed by other birds. Due to the group size of up to 400 poults per ring in ring rearing, the resting behaviour of intensively kept turkey poults is negatively affected in the first weeks of life compared to the extensively kept ones. The former hardly come to rest because the lying birds are repeatedly disturbed by the more active conspecifics (Dillier, 1991). The extent to which this could have an effect on later behavioural disorders can only be assumed. Similarly, Martrenchar et al. (1999b) found that resting behaviour in male and female turkeys was increasingly disturbed with increasing stocking density. Letzguß and Bessei (2009) compared the behaviour of turkey toms in a non-enriched barn with that in two open barns with elevated platforms, straw bales and wire baskets filled with hay. The enrichment structures influenced resting behaviour. The total time of locomotor activity was significantly lower in both enriched barns compared to the non-enriched groups, as the turkeys used the elevated platforms and straw bales for resting.

Furthermore, special resting areas created with barriers could be alternatives to perches or elevated platforms for older birds. Areas of lower activity could be created to reduce disturbance for resting birds. Sherwin et al (1999 b) investigated the incidence of injurious pecking using 120 cm x 30 cm plywood panels as visual barriers in the barn (as well as additional UV light for the length of the photoperiod, straw supplementation and pecking objects). The incidence was reduced very significantly. There are no individual scientific findings on the matter, however, as many possible influencing factors were used simultaneously in Sherwin's study. A possible problem of such barriers could be that they hinder harassed animals from escaping and there is also an increased risk of crushing in case of panic in the flock. To our knowledge, the effects of flexible barriers such as strip curtains have not yet been tested under real-life conditions.

Sick pen: From a veterinary point of view as well as from an animal welfare point of view, it is essential that injured but in principle viable turkeys as well as under-grown, weak or sick animals can be moved immediately to a separate sick pen and treated and cared for properly. Turkeys with an unfavourable prognosis, on the other hand, must be killed immediately in a manner appropriate to animal welfare. If no sick pen or separate sick pen is available, weak but in principle viable or treatable sick animals cannot be removed temporarily from the flock (VKM, 2017; Bundeseinheitliche Eckwerte, 2013).

To better implement the movement of sick animals, it is recommended to create a sick pen at each end of the barn so as to avoid long distances, especially for heavy, older animals. Hygiene and good litter management must not be neglected in the sick pens nor in the whole barn. Occupancy should be significantly lower than the stocking density of the rest of the barn. In a study conducted throughout Germany, such sick pens were found in only 17 flocks out of 24 turkey farms. Some fatteners dispensed with sick pens for turkey hens only, but not for turkey toms (Krautwald-Junghanns et al., 2009a,b).

4.2.2.2 Opportunities for elevated perching

Wild turkeys sleep in trees at night or seek shelter from predators there. Healy (1992) deduced from this that turkeys may feel safer if they are given the opportunity to roost in an elevated place. It also partially prevents crowding on the barn floor, which disrupts the turkeys' sleep cycle (Martrenchar et al., 1999b, 2001). The creation of elevated perching opportunities can therefore have benefits for animal welfare (Bircher et al., 1996):

- Exercise of species-specific behaviour at elevated positions (e.g. resting).
- Structuring into activity, retreat and rest areas to provide opportunities for retreat from aggressive conspecifics.

- Partial reduction of stocking density on the ground to reduce disturbance during resting phases by active animals.

General: The experimental conditions on this topic vary greatly. The results depend in particular on the dimensions of the stocking structure used, and on the sex, age and origin of the animals. Therefore, especially the utilisation rates cannot be compared in an equivalent manner.

Various solutions are available in order to comply with all the criteria mentioned: straw bales and wooden platforms arranged one above the other in the middle of the barn could be attached for mounting. The use of such devices requires habituation already in the rearing barn, however. Turkey poults should therefore already be offered simply constructed two-storey shelves along the wall of the barn.

The use of perches is not devoid of controversy. Such use often increases in the period between the 4th and 11th week of life, then steadily decreases until the end of fattening. Lighter fattening turkeys generally use perches to a greater extent than their heavy counterparts (Bircher and Schlup, 1991b; Berk and Hahn, 2000; Cottin, 2004). The generally poorer utilisation rates by heavy fattening turkey lines were explained primarily by the increased body weight and the associated deterioration in walking ability. Another aspect is likely to be the forward shift of the centre of gravity as a result of hypertrophied pectoral muscles. It should also be noted in general that misinterpretations may occur if there is not enough space for all animals on the perches. The fact that more space per animal is needed on the perch with increasing age should be taken duly into account. Furthermore, maintaining a larger individual distance between older animals could contribute to a reduction in use (Marks, 2017).

Ringgenberg and Stratmann (2018) reported that turkeys made very good use of the elevated perches up to a height of 80 cm, even to the end of the fattening period. Use was higher among young birds, with maximum use between 4 and 7 weeks of life. Their results moreover show that wooden boards are less suitable as elevated structures for turkeys.

Compared to perches suitable for feet, wide beams are little used at the beginning of the fattening period but are used better than the narrow perches at the end of that period. (Note: It is easier for heavy animals to keep their balance here. This is partly due to the sleeping position. Unlike songbirds, for example, chickens and turkeys lie down with their ventral side on the perch when sleeping). A ramp has proven effective in facilitating access to the perches, as even heavy fattening turkeys can then reach the perches on foot. In this way, at least 1/3 of the animals spent the night elevated (Bircher et al., 1995).

According to Strassmeier (2007), plateaus with appropriately sloping ramps for climbing up are preferable to perches, as they can also be used by heavy animals until the end of the fattening period. Further, in Strassmeier's (2007) outdoor trial, they served as additional weather protection, e.g. as shade in the sunshine or as a rain shelter.

Another possibility to enable turkeys to perch is to use straw bales, which also stimulate exploration behaviour. Furthermore, a certain littering effect is created when the animals work on the straw bales and they can be used at the same time as elevated platforms and stimuli for exploratory behaviour (Letzguß and Bessei, 2009).

Crowe and Forbes (1999) found through their research that perches and pecking objects were more effective in reducing injurious pecking than straw and scattered grain in the litter. However, straw bales are recommended as structuring elements. In addition to providing a place to perch, they create visual protection in the pen compartment and are pecked by the birds. The straw bales should be offered as of the 2nd to 3rd week of life. In terms of quantity, at least 1 straw bale (with a sitting-on area of approx. 2 m x 1.25 m = 2.50 m^2) is recommended for 2,000 animals from the 2nd to 3rd week of life, and for 400-500 animals from the 6th week of life (NMELV, 2019a). Huesmann (2008) also recommends the straw bales used in the model project "Animal-friendly fattening turkey husbandry with occupational and structural elements" from a labour management perspective. They incur low costs and are more practicable to handle than elevated levels.

Utilisation rate: Heavy turkey breeds utilise elevated bales depending on age, line, light period and stocking density (Berk and Hahn, 2000). Older studies in 1991/1995 found mean rates of perch use at night (Bircher and Schlup, 1991a) for turkeys of a light-weighted traditional breed ranging from 87% to 100% (proportion of birds using perches). Only 26%–56% of the Big 6 turkeys of the heavy type studied, used elevated roosts at night (Bircher & Schlup, 1991b).

During the light day, Bircher et al. (1995) recorded a mean utilisation rate of perches suitable for feet (squared timbers, 5 cm × 5 cm) of between 10% and 31% for conventionally kept turkey toms of a slow-growing line (Betina). The fast-growing Big 6 and Big 9 turkey toms also studied here showed a significantly lower utilisation of perches between 0-4% in the 14th week of life. In another study, the perch was widened to 11 cm.

As a result, the use by the Big 6 turkey toms reached a maximum of 40% in the 10th week of life and dropped to 30% by the 14th week of life. The use of the perch could again be significantly increased by installing ramps. The maximum use occurred in the 8th week of life (97% for Big 6 turkeys). The widening of the perch contributed to the fact that even heavy turkeys could use the perch better. It was assumed that this made it easier for the birds to keep their balance on the perch.

The utilisation rates of elevated levels could also be increased sustainably by providing a ramp in the studies by Marks (2017).

Martrenchar et al. (2001) offered Big 9 turkeys, among others, round wooden perches 5.5 cm x 8 cm thick. Perch use was more frequent in hens, peaking at week 5 (10% to 13% of birds) and declining to 0% at week 10. The birds were thus no longer able to sit on them from week 10 onwards. The authors attribute this in part to the design of the perches. The data on animal health collected did not vary between the groups with and without perches.

Berk and Hahn (2000) offered Big 6 and Nicholas 700 turkeys perches at a height of 0.2 m, 0.4 m and 0.6 m and, as of the 10th week of life, an additional perch at a height of 0.3 m. The perching width was 5.5 cm from the 2nd to the 5th week of life and 9.0 cm thereafter. The tread width was 5.5 cm in the 2nd to 5th week of life and 9.0 cm thereafter. In the weeks of life 2 to 21, the perches were well accepted by both breeds, whereby the Nicholas 700 turkeys used the perches significantly more often on average. In the first weeks of life, the perches at a height of 0.6 m were clearly preferred.

With regard to possible factors that influence perch use, Hirt (1998) already found a correlation between limited locomotion ability and a reduction in the probability of use. Where it was made easier for fattening turkeys to get up, the use of perches increased significantly (Hirt, 1998). Bircher et al. (1995) also concluded that the utilisation intensity of the two heavy lines was increased by offering wider perches.

Spindler and Hartung (2009) saw that conventionally kept Big 6 hens also liked to use elevated levels for resting at the beginning of their lives, but that this decreased with increasing age. Bircher et al. already stated in 1995 that here, too, the heavy weight and associated leg health problems contribute to a reduced intensity of elevated levels use (note: due to breeding successes in the last 20 years, “leg weaknesses” such as tibial dyschondroplasia have become rare, see also Kapell, 2017).

The influence of stocking density on the use of elevated levels was investigated in a second series of experiments by Berk and Hahn (2000). Big 6 turkeys with 1.5 animals/m² and with 3.5 animals/m² were kept in barns that were equipped with a platform incl. ramp. In this series of experiments, too, the use of the platforms was significantly greater in the dark phase than in the light phase at both stocking densities. At low stocking densities, however, the platforms were used significantly more often for resting than at higher stocking densities.

In a study by Cottin (2004), the influence of elevated levels/straw bales and additional offer of an outdoor run was investigated on fattening turkeys from 3 heavy and 3 light lines aged 6 to 19 weeks. The turkeys used the levels more often at night to perch. The proportion of turkeys on the elevated levels and the straw bales varied between the types and lines depending on the week of life and the observation period. On average, the heavy lines used the platforms better during the day and the light lines at night. The light lines used the perching facilities up to 20% more often on average than the heavy lines. The differences in the use of the perching facilities between the lines were explained by the fact that the light lines used the exercise area more during the day, whereas the heavy lines spent more time in the stable and used the resting facilities more often.

Even if elevated levels are offered, the stocking density requirements in relation to the usable floor space must not be exceeded. Elevated levels provide additional, not alternative space. Strassmeier (2007) compared the resting behaviour of Big 6 and Kelly Bronze turkeys on elevated levels and perches in free-range systems. A platform with a ramp at a height of 0.6 metres and an area of 2 x 1 metres (i.e. ca. 5.6 cm²/animal) and a perch combination (ca. 5.6 cm/animal) were provided per compartment. Maximum use was reached in summer on the perch at the 9th week of life and on the platform at the 11th week of life. Use decreased in the subsequent weeks until the 22nd week of life. The area under the platform was used increasingly as a retreat under such conditions, however.

The elevated level with a ramp used by Berk and Cottin (2005) was used by 27.6%–28.6% of male Big 6 turkeys, with higher use in turkeys with higher stocking density (50 kg/m²) than in lower stocking density (38.2 kg/m²).

More recent research by Marks (2017) in parent turkey hens showed that they used the perching options he employed sustainably throughout the entire period of use, in both the rearing and the laying phase. The hens in this study thus showed a fundamentally different behaviour than heavy fattening turkey toms of previous studies, which used perching options less effectively with increasing body weight. The perches were used significantly more often in the dark phase than in the light phase. This corresponds to the enemy avoidance behaviour of wild turkeys, which seek elevated positions for resting in the dark phase. For this reason, corresponding structures should also be offered to hens in turkey parent husbandry, at least in the dark phase, so as to enable them to perform species-specific behaviour.

The space requirements of the turkey parent hens, first determined in the work of Marks (2017), should be taken into account when constructing future platforms and perches. The following dimensions were given by the author:

- During the rearing period (height adjusted to age): two different platforms and 1 perch (width of 0.11 m) => 1 ramp per 3 m perch length and 1 ramp per platform; the perforated ramp with a width of 0.6 m and a length of 1.2 m; ramp angle 21.0° until the 16^{th} week of life and 31.7° after the 16^{th} week of life (~ 101 hens per m perch; ~ 180 hens per m^2 platform).
- During the laying period: one perch (i.e. either perches or one of both platforms) at a height of 0.5 m. For every 3 m of perch and for every 6 m of platform length, one ramp measuring 1.2 x 0.6 m (length x width) with a ramp angle of ca. 24.6°. The width of the perch was 0.11 m, as in the rearing phase. Perch length: 32 hens per m perch; 32 hens per m^2 platform.

In addition, the width of the platforms (ca. 0.6 m) was to be selected in such a way as to make possible the two-row arrangement of the hens and the associated high degrees of usage so that as many birds as possible could perch under conditions customary in practice.

In the studies that used straw bales, these were well accepted and used throughout the fattening period (e.g. Huesmann, 2008).

Health aspects: The study by Marks (2017) found no evidence to suggest a negative effect of housing structures (see above) relating to animal health (injuries, foot pad dermatitis and breast skin changes) and economic efficiency (floor eggs).

Conversely, in older studies from 1973, elevated platforms in turkey rearing led to an improved growth rate and feathering than on conventional floors. Mortality was experimentally higher in the first 14 weeks on modified elevated platforms but was unaffected as of the 14th to the 24th week of the experiment (Leighton and Mason, 1973).

In their study of conventionally housed fast-growing broiler chickens, Berk and Hahn (2000) found that birds using perches developed significantly more breast blisters. They concluded that resting on perches that are poorly designed may be more conducive to the development of breast blisters and that elevated levels rather than perches should be provided. These did not lead to a change in gait and leg position or to the occurrence of tibial dyschondroplasia in the experiment by Berk and Cottin (2005).

Crowe and Forbes (1999) showed that aggressive behaviour of fattening turkeys, especially pecking at other turkeys, could be reduced by providing perches during the first ten weeks of life. In this case, the perches were made of 4 x 4 cm squared wood and were 1 metre long. The frequency of use of the perch was significantly higher in weeks 1 to 6 than in weeks 7 to 9. As the use of the perch decreased, the incidence of feather pecking in the perch compartment increased significantly also.

In the study by Martrenchar et al. (2001), wing injuries occurred significantly more frequently in the control compartments without structures in weeks 7 to 11 among hens and in weeks 4 to 10 among toms than in the compartments with structures. The assumption that wing injuries could occur more frequently when the hens rise to the perches was consequently not confirmed.

Furthermore, the provision of perching facilities could counteract the often poor plumage condition of fattening hybrids towards the end of the fattening period, especially in the abdominal area, which is exacerbated by the fact that the birds often spend long periods lying on dirty, damp ground (Krautwald-Junghanns, 2003).

In the *Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V.* (KTBL) [Association for Technology and Structures in Agriculture] model project “Animal-friendly fattening turkey husbandry with occupational and structural elements” (Spindler et al., 2007), the effects of structural and occupational elements were investigated in 2 conventional and 3 organic turkey farms during fattening and at the slaughterhouse. The authors conclude that cubic straw bales are particularly advantageous in many respects, whereas round bales tend not to be usable as an elevated level due to their height and are therefore disadvantageous compared to their cubic counterparts. When using elevated levels with ramps, the labour time required (cleaning, etc.) and the purchase costs must be taken into account. A-racks and pallet stacks would be comparatively little used and the latter would also carry a certain risk of injury.

In a publication prepared for this purpose (Achilles et al., 2013), the authors come to the following assessment:

Element	Occupation	Retreat	Species-specific rest	Health	Injury risk	Labour requirement	Costs
Round straw bales	++	+	(++)✶	0	0	+	+
Cubic straw bales	++	+ / ++	++	0	0	+	+
Littered cubic raised levels	0	++	++	0	0	--	-
Hay baskets	++	0/+	0	0	0	-	-
Littered pallet stacks	0	0	0	0	-	--	-
A-racks	0	+	+	0	0	+	+

Analysis and evaluation of the structural and occupational elements used in the model project (Spindler et al., 2007) (cited from Achilles et al., 2013).

++ very positive, + positive, 0 no effect or no difference to the littered barn area – critical - -- very critical

✶ Round bales tended not to be used as an elevated level on account of their height and were therefore classified as disadvantageous compared to cubic bales (Spindler et al., 2007). In addition, according to Huesmann (2008), the hay bales in baskets used in the above model project resulted in very different use.

In the studies by Letzguß (2010), the perching options used did not lead to a verifiable increase in exercise activity. It was also shown that fewer animals were on the move on the structural elements on average than in the non-enriched space. This means that the structures made it possible to divide the barns into activity and rest areas and that the structural elements were used for resting.

4.2.3 Outdoor-climate area and outdoor run

4.2.3.1 Outdoor-climate area

General: Another part of the turkey house can be an outdoor-climate area with a paved floor. The outdoor-climate area should be roofed and have a littered floor surface. Its open sides are to be covered with air-permeable material (NMELV, 2019a). It is usually located on the long side of the barn, or in any event on the lee side. It is often provided as of the 6^{th} week of life, with the start of the fattening phase and when the animals are fully feathered.

An outdoor-climate area (also referred to as a winter garden or outside scratching area), shall provide the turkeys with direct access to the outdoor air and its climatic stimuli as well as with additional space to exercise species-specific behaviour, which is hoped to improve well-being and animal health (Spindler, 2007).

It was disputed whether the outdoor-climate area could be counted in full or in half in the stocking density so as to create an incentive for more housing facilities equipped with an outdoor-climate area (Berk 2002). In the NMELV (2019a) specifications, the usable area allowed for calculating the authorised stocking density is 50%. The creditable outdoor-climate area is limited to a maximum of 25% of the floor space of the barn (Bundeseinheitliche Eckwerte [Germany Voluntary Benchmarks], 2013). Such a 50% allocation gained by the outdoor-climate area could cover at least part of the additional costs and thus provide an incentive for the farmer to establish such areas (Berk and Kirchner, 2011).

An outdoor-climate area is already mandatory in certain label programmes (e.g., Beter Leven [Better Living] in the Netherlands, the Besonders Tierfreundliche Systeme (BTS) [Particularly Animal-Friendly Systems] programme in Switzerland, and “Tierwohl verbessert” [Improved Animal Welfare] in Austria). These include recommendations on the establishment and operation of an outdoor-climate area in turkey fattening (NMELV, 2019a). The Austrian Gesellschaft Zukunft Tierwohl (2018) requires that the outdoor-climate area should cover at least 25% of the usable barn floor area. The German NMELV (2019a) specifies that the outdoor-climate area should be at least 20% of the barn floor space. In Switzerland, this minimum area is also required under the “BTS” (Anonymous, 2000, cited in Berk, 2002).

The advantages of an outdoor-climate area for the animals include:

- direct access to the open air and its climatic stimuli
- additional space for the exercise of species-specific behaviours (movement)
- improved well-being and animal health (Berk, 2002, Spindler, 2007).

Utilisation frequency: Reported figures on the utilisation of the outdoor-climate area vary. In an experiment by Berk (2011), turkey hens at 7 weeks of age used the outdoor-climate area more frequently (50-70%) in the warm season than in winter (15-20%). However, very high temperatures resulted in less use of the outdoor-climate area, as did very low temperatures. Use also depended on the stocking density in the barn: Increasing stocking density resulted in a significant increase in mean time spent in the outdoor-climate area irrespective of the season. In previous studies, Berk et al. (2006) determined only an average use of an outdoor-climate area of 9% to 11% by Big 6 turkey toms, in an otherwise conventional housing system without an outdoor run. The author attributed the much more frequent use in the 2011 experiment (Berk, 2011) partly to the fact that hens had been studied there.

In studies by Cottin (2004), the averaged utilisation rates over the entire study period were found to be 13% and 23% for the light and 18-20% for the heavy lines. She examined males of 3 light and 3 heavy lines over two runs. Utilisation was also affected by weather conditions here.

Health aspects: Spindler (2007) endeavoured to assess whether an outdoor area exerts a positive influence on health and performance in practice a farm with a total of 3000 animals through clinical, pathological-anatomical and histological investigations. Two barns (barn 1 with outdoor area, 2.5 animals/m², and barn 2 without outdoor area, 2.8 animals/m²) were monitored for four fattening runs. In the summer runs, there were significantly fewer cannibalism injuries in the animals kept with outdoor area. Furthermore, tibial dyschondroplasia, pericarditis and changes in the respiratory tract were significantly less frequent in turkeys kept with outdoor area.

Berk and Wartmann (2006) also investigated the influence of an outdoor area during 4 fattening periods on the performance, behaviour and health of turkeys compared to a conventional, naturally ventilated barn without outdoor area. The results showed that turkey toms of the heavy turkey type (Big 6) used the outdoor-climate area without negative effects on health and performance parameters. There was evidence of improved bird health or reduced mortality in the barn with outdoor-climate area. No negative effects were seen from the outdoor-climate area compared to a conventional barn in terms of mortality, locomotion system, behaviour, plumage condition and feeding effort in studies by Berk and Kirchner either. Aggressive interactions seem to be generally reduced when an outdoor-climate area is provided, especially in the final fattening period (Berk 2002).

A tendency towards better plumage condition when turkeys are kept with outdoor-climate area was observed by Uchtmann (2004). The plumage of the birds from the structured groups (with outdoor-climate area) was also rated better in part by Cottin (2004) than that of the turkeys from the control groups. The walking ability of the heavy turkeys was also slightly better in the structured environments.

In terms of behaviour, more space-grasping steps, locomotion and wing flapping were reported in the outdoor-climate area than in the barn (Wartemann, 2005).

4.2.3.2 Outdoor run

General: The definitions of different types of outdoor housing can be found in Annex IV of Commission Regulation (EC) No 543/2008 of 16 June 2008 laying down detailed rules for the application Council Regulation (EC) No 1234/2007 as regards the marketing standards for poultry meat. In this context, a distinction is drawn between three forms of free-range husbandry (free range, traditional free range and free range – total freedom).

In a study conducted in France with free-range turkey farms, Callait-Cardinal et al. (2010) attempted to find associations between the variables that describe flock management through multivariate descriptive analysis. The aim was to reduce the number of independent variables before associations with disease were investigated. No homogeneous groups of farms were found in the 44 free-range turkey flocks sampled, however. This shows how different the outdoor run can be in free-range systems.

According to Commission Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) no. 834/2007 on organic production, labelling and control, fattening turkeys kept in fixed housing must have a minimum outdoor area of 10 m² per turkey (mobile housing: 2.5 m² per turkey). Various label programmes, such as the "Neuland guidelines for species-appropriate turkey husbandry", also contain requirements regarding outdoor access. Accordingly, fattening turkeys must have access to a green run from the twelfth week of life at the latest. The animals must have access to a green run for at least one third of their lives. This must be documented in an outdoor diary. In addition, there must be a green run of at least 6 m²/animal in fixed housing.

Frequency of use: Since the conditions of free-range husbandry vary greatly on site (and weather influences, age, sex, origin of the animals also play a role in the assessment), the utilisation rates in particular cannot be compared in an equivalent manner.

Bergmann (2006) observed seasonal differences in outdoor use for organically kept Big 6 and Kelly BBB turkeys. There was a significantly higher mean use of the run (proportion of birds using the run) of around 94% and 91% respectively in summer, while in winter this figure was around 36% for Big 6 and 56% for Kelly BBB. Strassmeier (2007) recorded a slightly lower mean rate of outdoor use of around 57% and 58% respectively for conventionally and organically kept Big 6 turkey toms in summer; for the Kelly BBB toms kept here, this figure was about 61% and 63%, respectively. However, Strassmeier (2007) also described a significantly lower use of the run in winter with a proportion for both lines of 7%-14%.

The conventionally reared Big 6 turkey toms studied by Berk and Hahn (2000) used the run to about 36%, while for Nicholas 700 turkey toms a run usage of about 42% was recorded.

In Cottin's (2004) study, between 15 and 63% of heavy turkeys from 3 heavy-weight breeds aged 6 to 19 weeks were observed in the first round of the run. For the slower-growing turkey lines studied, Cottin (2004) found a slightly higher mean use of the run of 50%-60% in the 15^{th}-18^{th} week of life. In the light lines, the proportion of locomotion in the run was also higher (ca. 28%-55%).

The results on the run usage between heavy and light lines are not homogenous, however. In the study by Bergmann (2006), as described above, the influence of the line on the run usage was different only in winter, with lighter lines also showing higher utilisation rates. Furthermore, a significant influence of age was described by Berk and Hahn (2000), where reduced utilisation rates were observed towards the end of the fattening period.

Health aspects: Free-range husbandry should help improve the low-stimulus and structureless housing environment, promote locomotor activity, strengthen the musculoskeletal system and thus have a positive influence on walking ability.

Active behaviour such as litter picking, walking and foraging are indicators of good health. Free-range systems are therefore recommended over indoor-only systems (Baboo et al., 2016). Turkeys kept with free-range access were more active than turkeys kept indoors. Baboo et al. (2016) showed that turkeys with free-range access spent more time litter pecking (23.51%), followed by walking (19.99%), eating (16.33%), preening (13.72%), feather pecking (6.07%), aggression (5.94%), drinking (5.90%), immobility (2.36%), standing (2.29%) and jumping (1.96%). By comparison, birds reared in the conventional system spent relatively more time lying (17.82%), followed by litter pecking (15.71), preening (12.93%), walking (11.47%), standing (8.35%), drinking (8.31%), aggression (6.85%), eating (6.46%), feather pecking (6.04%), immobility (4.59%) and jumping (1.46%).

In their study of conventionally housed fast-growing broiler turkeys, Berk and Hahn (2000) found that birds that had access to an outdoor run were less affected by breast skin lesions. Irrespective of the turkey line, the animals with access to an outdoor run had the largest proportion of unchanged breast skin (56%).

As regards the introduction of various pathogens (e.g. parasites, mycoplasma, etc., influenza viruses – risk due to the introduction of pathogens from wild birds) however, many authors have repeatedly reported a higher incidence when turkeys were kept outdoors.

4.2.4 Litter

General

Litter plays an important role in the rearing of fattening poultry. It is assigned various functions. For instance, it provides thermal insulation, protection from the floor slab, moisture absorption and release, and comfort behaviour (Jodas and Hafez, 2000; Abd El-

Wahab et al., 2011, 2012). Furthermore, fresh litter also partially serves as an occupational material and enables the exercise of exploratory behaviours.

An important behaviour for plumage care in wild turkeys is dust bathing, as it is thought to improve the structure of the plumage, increase the insulating capacity of the downy feathers and remove excess fat, thereby possibly also reducing the presence of ectoparasites. Wild turkeys usually dust bathe at midday (Hale et al., 1969). The soiling of plumage and skin/skin appendages is thus reduced with clean, high-quality litter, which must be changed daily to several times a week depending on the age of the birds and the degree of soiling.

Intensively reared broiler hybrids sometimes still show behaviour akin to sandbathing in the litter offered to them. However, sand bathing generally occurred only to a very small extent in the experiment by Letzguß (2010) (0.28% in the conventional barn). In another experiment, sand bathing also occurred rarely in Big 6 animals (Ellerbrock, 2002). Sherwin and Kelland (1998b) found no sandbathing at all in an experiment with Big 9 turkeys. The authors saw a possible reason for this in the condition of the floor (wood shavings or straw). Like Sherwin and Kelland (1998b), Spindler and Hartung (2009) did not observe any dust bathing behaviour in fattening hybrids, but in 12% of the observations feather cleaning was seen by the latter authors.

A significant problem in fattening turkeys is the development of foot pad dermatitis (FPD). Various studies have already shown that the moisture content of the litter and its water absorption and release potential play a decisive role in the development of pododermatitis (Mayne et al., 2007, Youssef et al., 2010, Wu and Hocking, 2011, Kamphues et al., 2011b, Krautwald-Junghanns et al., 2009 a, b, 2013). This not only affects conventionally fattened turkeys, but also those kept under organic conditions according to Regulation (EC) No. 889/2008 (Hocking and Wu, 2013, Bartels, 2020a). The moisture of the litter can thus be regarded as a decisive risk factor for the development of pododermatitis, while no positive influences have so far been shown through the use of slower-growing lines (Olschewsky, 2019).

The importance of this point is clarified all the more by the fact that most studies of conventionally kept turkeys have found prevalence levels of foot pad lesions of more than 90%. In Germany, Große Liesner (2007) found an average of around 97% foot pad lesions in the 20th to the 21st week of life. Mitterer-Istyagin et al. (2011) found foot pad changes in an average of about 98% of slaughtered turkey toms. These values were only scarcely lower in organically reared turkeys (Krautwald-Junghanns et al., 2017, Bartels et al., 2020a).

In Norway, by comparison, 39.4% of slaughtered animals were affected by FPD in 2013 (cited from VMK, 2016). The shorter lifespan of turkeys and the lower slaughter weight must be taken duly into account here.

Litter material

The litter material is of great importance, as different types of litter absorb liquids to different degrees and can exert a mechanical influence on the foot pads (Mayne et al., 2007). Litter substances should have high moisture-absorbing and moisture-releasing capacities. Litter materials with sharp edges (e.g. large wood chips) could promote the development of foot pad dermatitis due to their abrasive character. Ekstrand and Algers (1997) have shown that there was a significant correlation between the bedding material used and foot pad health based on slaughter evaluations of commercial fattening turkeys in Sweden. Straw resulted in a significantly higher prevalence of foot pad dermatitis compared to wood shavings (Ekstrand and Algers, 1997, Mayne et al., 2007).

Berk (2009b) compared different litter materials in turkey hens with regard to their influence on the development of foot pad dermatitis. Hens kept on lignocellulose for the entire fattening period showed the best results with regard to foot pad health. Youssef et al. (2010) tested the effects of wood shavings, lignocellulose, chopped straw and dried maize silage on the foot pad health of turkeys. In addition, half of the birds from each group were moved to adjacent compartments with moist litter (29% dry matter) for eight hours per day. The birds showed the lowest levels of dermatitis on lignocellulose. In the animals without the influence of high litter moisture, chopped straw again led to the highest degrees of dermatitis of all tested litter types. Youssef et al. (2010) assume that the reduced inflammatory reactions with lignocellulose are due to its higher water-binding and water-releasing capacity compared to straw. Furthermore, lignocellulose is characterised by being softer and lacking sharp edges.

In a study from Germany, flocks where spelt husks or spelt husk granules were used as bedding throughout the rearing phase in particular had a significantly lower prevalence of foot pad lesions than flocks where straw or softwood shavings were added. Young turkeys kept on softwood shavings before housing tended to have fewer foot pad lesions than those kept on straw (detailed report in Krautwald-Junghanns et al., 2017 and Bartels et al., 2020a).

Litter moisture

Litter moisture itself depends on various factors, including structural defects and damage, the type of watering system, the water absorption and release capacity of the litter, litter management and the barn climate (Jodas and Hafez, 2000). The first suggestions about the influence of litter moisture on foot pad health in turkeys were made as early as 1969 (Abbott et al., 1969). Mayne et al. (2007a) embarked on a whole series of experiments to determine the influence of litter material and moisture as well as excrements. The animals on moist litter (no indication of relative humidity) showed significantly higher degrees of inflammation macroscopically as well as histologically. FPD could be reduced in other studies by replacing the moist litter with dry substrate (no percentage of moisture given) whereupon the lesions began to heal (Martland, 1984).

Wu and Hocking (2011) and Schumacher et al. (2012) conducted experiments with one to ten week old turkeys to show that pathological foot pad findings can be reduced if litter moisture is kept below 30%. Conversely, litter moisture levels of more than 30% are likely to provoke pododermatitis within a relatively short period of time (Schumacher et al. 2012, Wu and Hocking 2011). Moist litter, on the other hand, is of multifactorial origin and not the same in every part of the barn (Krautwald-Junghanns et al., 2013). Further results prove that even a sub-area with increased substrate moisture suffices to increase the prevalence as well as the severity of foot pad changes. Even a 20% increase in substrate moisture led to increased food pad lesions. An increase of another 20 percentage points however no longer had a statistically significant effect on the clinical picture (Schumacher et al., 2012).

Litter height and management

Litter height, depth or thickness refers to the thickness of the litter substrate between the floor slab and the litter surface. There are hardly any scientific experiments on litter depth for turkeys. In broilers, experiments have shown that a litter depth of 5 cm is preferable to 2 cm in terms of the incidence of hock lesions (Grimes et al., 2002). In studies of 48 turkey flocks in France, Martrenchar et al. (2002) found that a thin layer of litter directly on the concrete slab dries faster and remains looser because the birds can scratch well here. With thicker layers of litter, crusts form on the surface, which can scarcely be broken up any more by the turkeys. The lack of thermoregulation in the first weeks of life on such thin litter is a problem, however (Martrenchar et al., 2002).

Abbott et al. (1969) had already ascertained that litter management, such as re-littering and loosening, is a pododermatitis reduction factor that should not be underestimated. Ekstrand and Algers (1997) expressed the suspicion that foot pad dermatitis occurs more frequently in turkeys than in broilers because the litter is less ventilated. They refer to Hale et al. (1969), who observed that scratching behaviour is less pronounced in turkeys than in broilers. This could also be the reason why the frequency of re-littering is more important in turkeys than in broilers (Geraedts, 1983). Another way to reduce the frequency of foot pad changes is to loosen/till the litter (Geraedts, 1983, Berg 1998).

A survey of turkey health and husbandry in Germany based on 24 fattening flocks studied shows that litter thickness and the frequency of re-littering vary widely. The farmers stated that they littered two to three times, or more frequently where necessary. The observations nonetheless revealed that the quality of the litter was sometimes inadequate (Krautwald-Junghanns et al., 2009a,b).

Length of exposure / further measures to reduce litter moisture

Mayne et al. (2007a) report that exposure on moist litter for 48 hours already suffices for foot pad changes to develop. Results from Celle suggest that even shorter daily exposure may be enough for damage to occur (Berk et al., 2013b). Furthermore, in the study with different litter materials in particular, Youssef et al. (2010) concluded that exposure on moist litter for eight hours per day suffices to promote the development of foot pad dermatitis in turkeys.

Berk et al. (2013b) were able to find a significant correlation between the length of exposure in the high litter moisture areas around the feed troughs and drinkers (consumption zones) and the age of the turkeys in experimental studies on the B.U.T. 6 and Grelier Bronzés 708 breeds, although the turkey breeds did not differ significantly in the length of exposure. Other investigators came to the same conclusion: the turkeys did not prefer the drier areas, but frequently stayed in the moister consumption zones (Schumacher, 2014; Monckton et al., 2020). The long stay of turkeys in the consumption zones, especially documented at the end of the fattening phase, is consequently seen as conducive to the inception of pododermatitis.

Measures that temporarily restrict the turkeys' direct contact with the litter are accordingly considered beneficial for foot pad health. Significantly lower litter moisture was found when using pendulum drinkers as opposed to round drinkers. Pendulum drinkers use nipples that are activated when the bird touches a pendulum. This means that only a comparatively small volume of drinking water is available, which is renewed and adapted to the demand. A positive influence on the litter moisture can apparently be exerted by reducing the splash water input into the environment on account of the design (Bartels et al., 2020a). The length of exposure to moist litter can also be reduced with elevated levels with foot-friendly designed grid floors, which are still visited by turkey toms in the final fattening phase (Berk and Kirchner, 2011).

The influence of barn climate parameters such as room temperature and humidity in the barn on the health of the foot pads has been documented by Ziegler et al. (2013); the higher the temperature and the lower the humidity, the better the health status of the foot pads.

Alternatives to keeping turkeys on floors with litter may need to be explored further. Studies conducted in the Netherlands with ventilated floors, for instance, showed that optimal flock development was achieved when about 50% of the barn area was equipped with an elevated perforated floor (Veldkamp 1996). Structural measures such as installing floor heating can also help to demoisturise the litter (Kamphues et al., 2011b). Abd El-Wahab et al. (2011) showed with their experiments that floor heating led to milder inflammation processes than were found in the turkeys without floor heating, irrespective of the litter material and moisture. They conclude that the use of underfloor heating can be seen as a further step to improving animal health and welfare. The positive effects of underfloor heating on the degree of dryness of the litter and thus on foot pad health were also confirmed by Bartels et al. (2020a).

4.3 Comments on lighting and indoor area requirements for turkey housing

4.3.1 Lighting

The visual sense of birds is superior to that of other classes of vertebrates. Their visual acuity can be six times higher than that of humans, for instance (Bartels et al., 2017).

There is therefore consensus among scientists in considering that light perception is of great importance turkeys which have a highly developed visual sense and for which light is a main impulse generator (Vehse, 1998).

Natural daylight and/or artificial light is provided in turkey fattening. Daylight is used in turkey fattening in the widespread “open stable”. An incidence of natural light through light openings is required in part, where the total area corresponds to at least 3% of the barn floor space (e.g. Bundeseinheitliche Eckwerte, 2013). The necessity of daylight has not yet been corroborated by scientifically sound findings, however.

The natural habitats of chickens (originally in tropical and subtropical forests of South Asia) differ from those of turkeys (steppes, forest edges and light forests of Central and North America). Kämmerling et al. (2017) suggest that birds that prefer a habitat with a canopy have different light source requirements than those that prefer to live “in the open”. Accordingly, the poultry house should be illuminated differently depending on the species, and probably even according to functional areas (Kämmerling et al., 2017). The “outdoor” measurements carried out by Kämmerling et al. (2017) show that daylight can be characterised very well. Considerable differences in the composition of the light were found for the respective locations. A generally valid definition of daylight is consequently not possible.

Conventional lighting devices such as commercially available energy-saving lamps or LEDs are designed primarily to meet human requirements. The optical perception of diurnal birds such as turkeys however differs from that of humans in particular with regard to the visible light spectrum and the flicker fusion frequency, i.e. the resolution frequency for light of changing intensity.

The quality of light can have a considerable effect on the behaviour of turkeys (cf. inter alia, Denbow et al., 1990, Sherwin, 1998, 1999, Sherwin and Devereux, 1999b, Moinard and Sherwin, 1999, Moinard et al., 2001). Light duration, intensity and brightness, and flicker fusion frequency of light for instance are thought to play a role in the occurrence of cannibalism and feather pecking (e.g. Martrenchar, 1999; Sherwin et al., 1999a and b; Korbel and Sturm, 2005). Studies by Moinard et al. (2001) on the effect of light intensity, light source and light regime in turkeys showed that fluorescent light, subdued light and short light duration reduced the incidence of pecking injuries. Therefore, as already mentioned, a light spectrum (in terms of light source, duration, intensity and colour) adapted to the turkey's requirements should be taken into account when using artificial light (for more detailed information, cf. Annex 4, Merkblatt – Anforderungen an Kunstlicht in Geflügel haltenden Betrieben, NMELV, 2019c).

Deviations from the lighting programme are permissible during the acclimatisation period, in the rearing and housing phase or when indicated by a veterinarian. For example, the light intensity is lowered to minimise stress during the housing phase. In the rearing phase, the light intensity and lighting duration should be oriented individually to the age and behaviour of the turkeys. When day-old chicks are housed, a lighting duration of 22-24 hours is recommended for the day of housing to enable the chicks to get initially oriented in the barn. By way of orientation value, the lighting duration can be reduced by approx. 1 h daily, so that a continuous light phase of 16 h can be achieved with artificial lighting as of the 7th day of life. The length of the dark period must be based on the natural day-night rhythm and, if there is a deviation from the natural, seasonally fluctuating dark phases, it must be at least 8 h, which should not be interrupted by a light phase (with the exception of extreme heat periods).

4.3.1.1 Luminous flux (light intensity)

Light intensity has in particular a great influence on activity and thus on the expression of various behavioural patterns and seems to be positively correlated with cannibalism (Lewis et al., 1998 a). The light intensity of the light phases should be at least 10 lux during the entire fattening period (Vehse, 1998). Furthermore, according to the European Convention for the Protection of Animals Kept for Farming Purposes – Recommendation concerning Turkeys (Meleagris gallopavo ssp.) (2001), the minimum illumination at eye level of the animals must be 10 lux, measured as an average in three planes at right angles to each other. At light intensities below 10 lux, turkeys show in particular lower activity, less plumage care and lower feed and water intake (Korbel and Sturm, 2005).

Various guidelines/recommendations for turkey husbandry recommend a lighting intensity of 20 lux. A scientific experiment justifying this figure has not been found. Due to different lighting intensities and a varying experimental set-up, the results on the preferred lux number are not consistent because of different lighting intensities and varying experimental setup.

Twilight vision in turkeys is limited (Korbel and Sturm, 2005). Turkeys appear to be largely inactive at night, although they may rise two to twelve times in the dark, usually turning slowly and lying down again (Sherwin and Kelland, 1998a,b).

Turkeys prefer brighter environments and avoid entering environments lit at less than 1 lux (Barber et al., 2004, Kristensen, 2008). Sherwin and Kelland (1998a) also observed that turkeys avoided spaces that had less than 1 lux of light intensity compared to 5, 10 or 25 lux. According to Siopes (1984), turkeys can also develop ocular anomalies if kept at 1 lux for long periods.

Additional studies have shown that turkeys may prefer different light intensities for different activities and that there is also an age dependency. For example, Barber et al. (2004) conducted experiments in which turkeys were given uninterrupted access to 4 rooms with different light intensities (<1, 6, 20 and 200 lux). In the 2nd week of life, turkey poults spent most of their time in the brightest environment. At the end of the rearing phase (week 6), the authors observed a division of behaviour. Resting and perching were observed only in the environment below 1 lux, while the rest of the behaviours occurred in the two brightest environments.

Turkeys presumably perceive bright light particularly intensively. It is worth noting here that the brightness levels of the different colours are perceived differently by birds than by humans. Excessively bright light may therefore be a triggering factor for feather pecking. Values significantly above 20 lux can trigger this behavioural disorder in intensive husbandry (Sherwin et al., 1999b). For example, Leighton et al. (1989) found more social disputes and higher mortality in turkeys kept under 86.1 lux than at lower light intensities. Also in an experiment by Hester et al. (1987), turkeys housed at 20 lux showed a greater tendency to cannibalism than turkeys housed at 2.5 lux. The extent to which the latter is due to poorer recognition of conspecifics can only be conjectured.

According to Vehse and Ellendorf (1999), the growth of turkeys is influenced essentially by light intensity and light duration. Various experiments with different light intensities have been conducted in the past concerning feed intake and conversion in fattening turkeys. The results are not uniform. Yahav et al. (2000), for example, examined fattening turkey toms between the 5th and the 18th week of life under 10-700 lux, whereby the weight development/feed conversion of the oldest turkeys was best at the lowest lux level. Conversely, Leighton et al. (1989) and Denbow et al. (1990) investigated different light sources and intensities (10.8-86.1 lux) in turkey toms and hens and found that these had no influence on feed conversion and weight development. Siopes et al. (1989) examined turkey toms from the 2nd to the 22nd week of life with 10.8-108 lux and could also see no effect of light intensity on body growth. This is contradicted partially by the experimental results of Hester et al. (1987), who examined male turkeys from the 4th day of life under 2.5 and 20 lux. The birds kept at 20 lux had a higher body mass but poorer feed conversion and were less active than those kept at 2.5 lux.

4.3.1.2 Light duration

The activities and resting behaviour of turkeys are influenced significantly by the light regime (Vehse and Ellendorff, 1999). Light duration is also of decisive importance for growth (Siopes et al., 1989) and the course of sexual maturation (Vehse and Ellendorf, 2000) in turkeys.

Turkeys can see very well during the day, whereas their twilight vision is limited, in contrast to nocturnal animals, for instance. Turkeys are therefore inactive during the night. Their activities are restricted exclusively to the light day. A strong restriction of the light day should consequently be rejected. Turkeys react very sensitively to changes in daylight hours. A clear day/night rhythm has a positive effect on flock health therefore (Günther, 2001). Although the birds show resting behaviour even under continuous lighting, relaxed sleeping phases and a common resting phase in the barn do not occur (Vehse and Ellendorff, 1999).

In the first days of life, the chicks need intensive lighting to ensure feed and water intake. After the first week of life, the light duration is 16 hours maximum, with a dark phase of at least 8 hours (Hafez, 1999).

Various authors have investigated the effect of different intermittent light durations, e.g. on the growth and sexual maturation of turkeys. The sum of the light phases can thereby be equal to or different from the dark phases, and the individual phases can be of different lengths (for more details cf. Hester and Kohl, 1988, Vehse and Ellendorff, 1999). However, Gill and Leighton (1984) were unable to show any differences between intermittent (2L:2D) light duration and a diurnal rhythm (12L:12D) for turkey behaviour under different stocking densities.

4.3.1.3 Light spectrum

The UVA component of light is of particular importance for turkey behaviour (cf. Burkhardt, 1989, Finger and Burkhardt, 1994, Moinard and Sherwin, 1999; Korbel and Sturm, 2005). This UV sensitivity is now known to play an important role in bird behaviour, which is largely guided by the visual sense. In this context, Moinard and Sherwin (1999) were able to show that turkeys prefer light with a UVA component.

The colour sensitivity of the eyes of many diurnal birds far exceeds that of the human eye. Whereas humans possess photoreceptors that are sensitive to blue, green and red (trichromatic vision), many birds have been shown to possess tetra- or pentachromic vision, i.e. they have retinal sensitivities to violet and/or ultraviolet light in addition to sensitivities in the blue, green and red spectral regions (Hart et al., 1999; Prescott and Wathes, 1999; Barber et al., 2006; Lewis and Morris, 2000b; Saunders et al., 2008). Thanks to this ability, many diurnal birds are also able to perceive ultraviolet radiation. Owing to ultraviolet light reflections, objects that appear monochrome white or black to the human eye can therefore contain specific colour impressions for a bird (Rajchard et al., 2009). Their ability to distinguish a variety of possible mixed colours expands the spectrum of perceivable colours considerably (Bennett et al., 1994; Weidensaul et al., 2011).

In addition to colour receptors, UV-sensitive sensory cells are found in the retina of the turkey eye (Hart et al., 1999). Since the parts of the eye in front of the retina are also UV-transmissive, it can be assumed that turkeys are able to perceive ultraviolet light, known as UVA radiation (wavelengths of 315-380 nm) (Hart et al., 1999; Prescott and Watthes 1999). UV reflectographic studies have shown that the skin of certain body regions as well as the plumage of white fattening turkeys show clear UV reflections under UVA illumination (Bartels et al., 2017). It can therefore be assumed that birds that appear as feathered white to the human eye show a mixed colour of white and ultraviolet under full spectrum illumination to the turkey eye. In bronze turkeys, on the other hand, UV reflection is limited to defined markings in the plumage.

Intensive husbandry uses UV-filtered daylight and electric lamps that do not emit UV light, so that the turkeys' colour vision, which differs from that of humans, is altered. If the turkeys are kept under artificial light alone, the different spectral composition of artificial light compared to daylight can lead to deviating reactions in the organism (cited from Vehse, 1998).

If the UV spectrum of the light is missing, for instance due to windowpanes that only allow UV-filtered daylight to pass through, or in the case of artificial light without UV content, the reflection in the feathers is altered, and may possibly account for an increase in feather pecking (Korbel and Sturm, 2005).

As already mentioned, Bartels et al. (2017) were able to find intensive UVA-reflective components in the plumage of male turkeys in their experiments. Due to the lack of UV radiation, such markers (= fluorescent and non-fluorescent areas), which are visible only with UV light, could look altered in the plumage. This unnatural appearance could lead to feather pecking (Sherwin et al., 1999 b, c). Sherwin and Kelland already found in 1998 that significantly less cannibalism occurred when UV light was used. Feather pecking was therefore seen for the first time at the very sites of such markers under conventional low UV light conditions (Sherwin et al., 1999b). In further studies by Sherwin et al. (1999 b), the incidence of feather pecking was reduced very significantly with additional UV light for the length of the photoperiod in conjunction with other measures (visual barriers, straw bales).

No influence on injurious pecking could be seen by keeping turkey poults under fluorescent or intermittent light during the rearing phase up to 35 days (Sherwin et al., 1999c).

4.3.1.4 Flicker fusion frequency

In addition to the importance of brightness, the flicker fusion frequency of the lamps used in the barn plays a major role. With a resolution of up to 150 Hz, the bird's eye has a much higher maximum flicker fusion frequency than the human eye (60-80 Hz) (Burkhardt, 1988). The flicker fusion frequency of lamps used in turkey fattening is usually significantly lower. Although not perceptible to humans, this can lead to negative influences on the birds due to the associated resolution of a single movement into many individual partial movements. When keeping turkeys with artificial light, care should consequently be taken to use flicker-free light sources (Korbel and Sturm, 2005).

To increase the flicker fusion frequency above 150 Hz, electronic ballasts should be installed when fluorescent tubes are used. Special fluorescent tubes which a light spectrum that extends into the UV range should be used to provide appropriate lighting for the turkey's vision when turkeys are kept exclusively under artificial light conditions.

Alternatively, multispectral LED lighting adapted to the turkey's visual spectrum could be suitable for barn lighting (Parvin et al., 2014).

4.3.1.5 Light colour

The brightness levels of different colours are perceived differently by birds than by humans. Growth and sexual stimulation of turkeys are promoted by red light – in contrast to blue or green light (Lewis et al., 2000b). Turkey activity, and thus possible aggression and exposure to social conflict, increases under red light (Lewis et al., 2000b). Nevertheless, it was previously recommended to switch to red light to combat cannibalism on the grounds that red colours (bleeding) are poorly perceptible under red light (Manser, 1996).

Blue light has a calming effect (Lewis et al., 2000b). Observations further indicate that, in contrast to red light, blue light has a positive effect on the behaviour of turkeys by attenuating social disputes, but leads to a decrease in overall activity and a delay in sexual maturity (Levenick and Leighton, 1988). In this context, however, it cannot be ruled out that the different effects of different light colours could also be partially due to an associated poorer visual ability (Vehse, 1998). Gill and Leighton (1984) were able to improve weight gain in early growth phases with blue light compared to white or red light. In later growth phases, on the other hand, white or red light led to an increase in weight gain.

4.3.2 Indoor climate

The barn climate is an important factor for optimal rearing conditions. In addition to the type of housing, the regulation of the barn climate and thus the housing environment is also an important factor for animal health. An optimal ventilation system and barn shell are required in order to avoid energy losses and climate-related diseases (Berk, 2002).

Different ventilation systems are used (free ventilation, forced ventilation). Fattening turkeys are kept mainly in barns with free or gravity ventilation ("open barns"), and more rarely, in closed barns with forced ventilation (Berk, 2002). There are specific planning and calculation principles for the planning of closed barns in individual countries, which, in addition to specifications for calculating the air flow in summer and winter, also specify temperature ranges depending on the animal species and weight.

The barn climate factors include air temperature, relative humidity, the content of harmful gases and dust as well as air velocity, which can be considered separately (see below), but which also have a combined effect on the animal and interact. For example, Mendes et al. (2020) tested 7 different combinations of temperature, relative humidity and air velocity in turkey poults (3 poults/m²) aged 61, 96 and 131 days in small groups of 7 birds each. The young birds suffered more from the combination of low temperature and high air velocity, which was seen to reduce water and feed intake. Increased humidity at low temperature increased the incidence of injury, trembling and cannibalism. Mendes et al. (2020) came to the following combined recommendation: temperature, relative humidity and air velocity combined of 26.6°C, 71.2% and 1 m/s respectively for young birds and 22°C, 50% and 1m/s for older birds. In view of the very small group sizes of 7 birds/group in the experiment and the high number of variables tested, however, these figures are subject to question.

By contrast, Yahav et al. (2008) arrived at different recommendations. They studied the performance of young, 4-6 week old turkeys at different temperatures. Turkeys exposed to 35 °C showed optimal performance at an air velocity of 2 m/s, as well as significantly higher feed intake and clearly lower body temperature. At 30 °C, performance was optimal at an air velocity of 1.5 to 2.5 m/s, but significantly lower at 0.8 m/s. The performance of turkeys kept below 25 °C did not vary with air velocity. A comparison of body mass and feed intake showed significantly higher feed intake at 25 °C, but similar body mass compared to those exposed to 30 °C, suggesting that the birds exposed to 25 °C used more energy for maintenance than growth. The authors concluded that air velocity affects the performance of young turkeys and that the combination of 30 °C with an air velocity of 1.5 to 2.5 m/s was optimal for them.

Ziegler et al. (2013) demonstrated a significant correlation between temperature and foot pad health and humidity and foot pad health: the higher the temperature and the lower the humidity, the better the health status of the foot pads.

According to Martrenchar (1999a), a poor climate in turkey barns is a direct consequence of high stocking densities also. This is often associated with low ventilation rates.

4.3.2.1 Air temperature

Rearing phase: The basic need of the animals for warmth must be taken duly into account. To assess their welfare, it is always important to obtain feedback through constant observation of animal behaviour. Trained staff should pay attention to the animals' vocalisations and even use of space, among other things. Turkeys already have well-developed down feathers when they hatch. They are not yet fully able to regulate body heat in the first days of life however and are therefore very sensitive to cold temperatures (Berk, 2002). An air temperature of at least 20 °C should be reached at the time of housing if additional heat sources such as radiant heaters are provided. Under these, the temperature should be about 35 °C. If the temperature is too warm or too cold, there is a risk of stifling due to crowding of the animals (Feldhaus and Sieverding, 2001). In ring-free rearing, the German turkey breeding company Kartzfehn (2017) recommends a constant room temperature of 36-37 °C for the first week of life, followed by a gradual reduction to 22 °C by the 5th week of life. Hendrix Genetics (Hybrid, 2015) recommends 30-34 °C for the first few weeks of life, followed by a gradual reduction to 16-17 °C until fattening. According to Teeter et al. (1996), the comfort zone of ambient temperature for turkeys is 29-32 °C at hatching and decreases to about 24 °C by the 4th week of life. The temperature can be assessed on the basis of the distribution of animals in the barn/ring. If the temperature is optimal, the poults are evenly distributed.

Fattening phase: The temperature should be evenly distributed throughout the barn. Here, once again, daily animal observation is the best indicator for heat adjustment. Birds are homoiothermic creatures and can thus regulate their body temperature themselves. Turkeys have a constant core body temperature of 40-43 °C (Hoy et al., 2006). In the thermoneutral zone, the body temperature can be kept constant without energetic expenditure. Outside this zone, the animals have difficulties with thermoregulation and health problems can occur if the temperature deviates for a longer period of time (Richter, 2006). The thermoneutral zone depends on various factors, such as animal performance, age or husbandry. As soon as the turkeys are fully feathered at the end of the 6th week of life, they are relatively well protected against cold. Their thermoneutral zone is then between 10 °C and 20 °C (Berk et al., 2006). Hendrix Genetics (Hybrid, 2015) recommends a gradual reduction of the temperature to 16-17 °C by the time of final fattening.

As the ambient temperature drops, the feed requirement increases to maintain the body's higher heat production as more heat is released (Löliger, 1992). Slowly rising temperatures do not bother the animals as much, but sudden temperatures above 35°C cannot be compensated for, which is why the importance of a good ventilation system is particularly great for heat days. Turkeys do not have sweat glands. They can release excess heat only through intensive panting as well as through the skin surface, e.g. by exposing less feathered parts of the body. With the onset of high temperatures, the animals become sluggish and tend to lie increasingly on the ground (Frackenpohl and Meyer, 2005). Keeping turkeys at too high temperatures leads to an increase in respiratory and heart rates, which is associated with a heavy strain on the tissues and can lead to health problems (ten Haaf, 1997). Appropriate countermeasures are particularly important here (cf. code of practice on avoiding heat stress, NMELV, 2019b).

4.3.2.2 Air humidity

According to industry recommendations, the humidity in the barn should be between 50% and 70% (Kartzfehn, 2017). If it is too low, the dust content in the air increases. If it is too high, heat cannot be released from the animals through evaporation (Berk, 2002). At humidity levels below 40%, as occurs especially in winter months with high temperature differences between indoors and outdoors in the heavily heated barns, the mucous membranes dry out and respiratory diseases can ensue (Richter, 2006). If the humidity is too high, heat dissipation is prevented by evaporation, which has a negative effect on animal welfare, especially at high temperatures. Excessive humidity can lead to damp litter and its consequences (pododermatitis, etc.) and high ammonia concentrations (VKM, 2016).

4.3.2.3 Dust content

The dust content in the barn air comes from the animals (dander, feather particles and faeces) and the feed on the one hand, and from the litter material on the other, and is also influenced by a variety of factors. These include the movement activity of the animals, the feeding system, type of litter, temperature and humidity in the barn and the age of the birds. Dust has a hygienic significance for the animals due to its burden on the respiratory tract and its carrier function for toxins and microorganisms (Hoy et al., 2006). A distinction is made between inhalable and respirable dust. The latter, with a diameter of less than 5 µm, must be given special consideration (Berk, 2002).

According to Hartung (1997), who investigated dust concentrations in different poultry species, the highest dust concentrations of 3-21 mg/m³ were measured in floor-kept turkeys. According to a study by Wathes (1994) (cited in Berk, 2002), the recommendation for maximum levels of inhalable dust is 3.4 mg/m³ and of respirable dust 1.7 mg/m³. In a study by Ziegler et al. (2013) in conventional fattening turkey houses, all measured total dust concentrations were below an average value of 1.27 mg/m3.

4.3.2.4 Noxious gases

Ammonia is one of the decisive gases for assessing noxious gas exposure in the barn. It is perceptible to humans from a concentration of ca. 10 ppm. The pH, temperature and humidity of the litter play an important role in the formation of ammonia. Ammonia irritates the mucous membranes and impairs breathing (Berk, 2002). A study by Nagaraj et al. (1983) showed that a sustained level of 10 ppm causes degeneration of the ciliary epithelium of the mucous membranes in turkeys. Other studies have shown that high levels of ammonia impair growth (Charles and Payne, 1966) and increase susceptibility to disease and mortality (Kristensen and Wathes, 2000). The Welfare Standards for Turkeys (RSPCA, 2010) therefore call for a maximum permanent ammonia level of 5 ppm, measured at animal eye level, because unlike humans, turkeys are permanently exposed to ammonia. The concentration of ammonia in the barn air is a good indicator of appropriate litter and ventilation management. Very high ammonia levels are indicative of damp litter and insufficient ventilation, which also prevents the litter from drying out (Ziegler, 2013). The ascertainment that foot pad health in broiler chickens decreases with increasing ammonia concentration is in line with the results of the study by Nagaraj et al. (2007), according to which foot pad health could be improved by up to 10% by reducing the ammonia released in the air by adding $NaHSO_4$ to the litter.

Guideline values are available for other harmful gas concentrations such as CO_2 (< 3000 ppm, Wathes, 1998; Martrenchar, 1999), CO (< 10 ppm, Wathes, 1998) and H_2S (< 10 ppm, Glatz and Rodda, 2013, and 0.5 ppm, Commission internationale du génie rural, 1992, cited in Berk, 1999), which affect humans and animals.

4.3.2.5 Ventilation

Turkeys have a high requirement for fresh air and need twice the air exchange rate per hour/kg as broilers (Veldkamp, 1996). As a general rule, according to the turkey rearing company Kartzfehn (2017), turkey barns should be ventilated with a constant ventilation ratio of 1 m^3/kg live weight/hour. This appears to be far from the values recommended in the literature, however (Martrenchar, 1999a). In Norway that the ventilation capacity for turkeys is regulated by law and must be at least 3.4 m^3/kg/hour (Norwegian Ministry of Agriculture and Food, 2001).

According to a study by Leighton and Mason (1973), medium to heavy turkey strains can tolerate fairly wide ranges of ventilation rate during the 18^{th}-24^{th} week of life without affecting growth or market quality. However, feed conversion was improved when the ventilation rate was increased from 37.4 to 56.1 litres of air/kg/min (2.2 to 3.4 m^3/kg/hour).

For his part, Wathes (cited in Berk, 2002) described as early as 1998 that the minimum ventilation rate needed in order to have acceptable dust levels should be 3.66 m^3/kg/hour. According to Tüller (1997) and Berk (1999), good air circulation (air exchange rate of 5-7 m^3/kg/hour, or 4 m^3/kg/hour for young animals) throughout the barns (dead corners must be taken into account) is a prerequisite for successful rearing.

Measurements should always be taken at the height of the animals not of humans.

High air velocities destroy the boundary layer surrounding the organism and thus promote heat dissipation. Draughts should be avoided.

The air circulation and ventilation of the barn should be controlled automatically, whereby the desired barn temperature can be maintained with precision via a thermostatically controllable system. Additional vents should be installed in the roof area with and without fans. In the case of open barns, a two-part control per louvre/side is recommended for better control of the air temperature, whereby optimal control of the air supply is achieved by the climate computer for four different sub-areas of the house (Feldhaus and Sieverding, 2001).

An emergency power generator is necessary for all supply systems that run on electricity, and in the case of electrically operated ventilation systems, an alarm system is also necessary to report the failure of the ventilation to the animal owner. The alarm system and emergency power generator must be checked at least once a week to ensure that they are functioning properly and once a month under load.

Reduced ventilation management in the winter months can lead to an increase in humidity in the barn. The litter cannot dry and sticks together (Ziegler, 2013). Pododermatitis is consequently often a bigger problem in winter than in summer (Mayne, 2005), if the animal owner does not take appropriate measures such as loosening the litter material or spreading sufficient fresh litter over it.

The Bundeseinheitliche Eckwerte [German Voluntary Benchmarks] (2013) recommend that additional measures must be taken to dissipate the animals' own body heat at the latest when enthalpy values of 67 kJ/kg outdoor air are expected for animals in the final fattening phase (as of the 14th week of life). The enthalpy value of 67 kJ/kg, for example, is already reached at an outdoor temperature of 25 °C and relative humidity of 80%. For extreme heat periods, ventilation should be designed to achieve an air exchange of 5-6 m^3/kg live weight and hour for hens and 6-7 m^3/kg live weight and hour for toms in the animal area (NMELV, 2019c).

The availability of scientific studies on the next two sections (4.4 and 4.5) was very limited (excl. the section on occupation materials). The texts therefore refer largely to recommendations from monitoring authorities and scientific bodies.

4.4 Comments on the requirements for care including the monitoring of turkeys

All measures that require manual handling of the birds should be carried out by trained personnel in an animal welfare-friendly manner from hatching onwards. The interaction/observance of many small details in the course of husbandry can play a decisive role in a more rewarding turkey fattening appropriate for the species. Constant feedback from those involved in monitoring production during fattening is therefore necessary. Checking the birds several times a day is essential in all phases of life

(Krautwald-Junghanns, 2003). This should be done at least twice a day, and preferably more frequently.

Weak or sick animals must be moved immediately to a separate sick compartment and treated or put down in a manner appropriate to animal welfare. Dead animals must be disposed of as quickly as possible (Council of Europe Recommendations, 2001). To proceed thus beyond theory only, regular records should be kept on the monitoring of animals / on the number of animals in the sick pen and presented to the supervising veterinarian / the competent authority upon request. One point under discussion in this context is the trimming of the upper beak (see Annex 3). The aim should be to keep turkeys with an intact upper beak, but this requires special monitoring (NMELV, 2019a).

4.4.1 On-farm self-monitoring requirements

"All those who keep or care for fattening turkeys shall ensure that at least twice a day

- the well-being of the fattening turkeys is checked by direct visual inspection by a competent person and any dead animals found are removed immediately;
- the condition of the litter is checked.

The keeper shall monitor water and feed consumption daily and record any deviations in water consumption. The records shall be presented to the competent authority upon request" (BMEL, 2015b).

The keeper's responsibility is defined by the Bundeseinheitliche Eckwerte (2013) [Germany Voluntary Benchmarks] as follows:

Keepers of turkeys shall ensure that all persons employed or engaged by them to care for or to catch and load turkeys have demonstrably up-to-date relevant knowledge and skills for animal welfare, including appropriate stunning and culling methods, in accordance with their tasks and responsibilities. All those who keep turkeys shall ensure that all turkeys on the farm are inspected at least twice daily. Attention shall be paid to their health and welfare. At the same time, the functioning of the technical facilities shall be checked (to ensure ventilation and the water and feed supply) as shall the quality of the litter.

Keepers of turkeys shall ensure that the layer of litter with which the birds come into direct contact is loose and dry by the day of exit. They shall arrange for the birds to be inspected by the supervising veterinarian at least once a month. A record of each of these visits shall be drawn up with a veterinary assessment of the health and welfare status of the flock, taking into account foot pad health. The report shall also indicate any measures recommended by the veterinarian. This record shall be presented to the competent authority upon request.

Pursuant to the recommendations of the NMELV (2019a), the keeping of turkeys with an intact beak in intensive husbandry requires a significantly more complex animal control than the keeping of debeaked birds. Intensive animal care and observation are urgently required so as to enable the caretakers to recognise any change in behaviour and/or appearance immediately and to take appropriate action without delay. It is recommended that the entire flock be inspected at least 3 to 4 times a day – even more frequently in the case of acute cannibalism – whereby particular attention is to be paid to the first signs of pecking injuries.

Critical phases in which more frequent inspections should be carried out can include for example times of plumage change or change of feed, a change in the weather and the onset of sexual maturity in the toms. When going through the barn, the areas along the outer walls, in the corners of the barn and under feed or water troughs or under or on structural elements should be checked carefully because injured or sick animals often retreat there. Turkeys are sensitive animals that react immediately to changes in care (e.g. changing staff at the weekend) or in the environment. Precise arrangements by the care staff are therefore urgently required (NMELV, 2019a).

4.4.2 Health monitoring programme

All facilities should have a written health management plan for the animals (Council of Europe Recommendations, 2001).

Each keeper of fattening turkeys must have his flock attended to by a veterinarian on a monthly basis as part of the on-farm inspections. The monthly care of the flock includes at least:

1. Advice to the keeper on how to maintain and, if necessary, improve the health status of the flock, and

2. The clinical examination of the fattening turkey flock; an examination key shall be drawn up for each individual farm and documented in writing to ensure that the time required for the clinical examination is sufficient to examine each individual animal. The time spent on the clinical examination must be in proportion to the size of the farm.

3. A report shall be drawn up on each visit, containing a veterinary assessment of the state of health and care of the flock of fattening turkeys, with particular reference to the health of the feet and the use of antibiotics and painkillers. The report shall also include the recommendations made by the supervising veterinarian as well as the measures initiated by the keeper to implement these recommendations in terms of content and time. The record shall be submitted to the competent authority on request.

4. The keeper of fattening turkeys shall calculate the daily mortality rate of each fattening day for each barn unit (BMEL, 2015b).

4.4.3 Dealing with sick animals

The sick pen is used to remove temporarily from the flock weak/sick animals that are in principle capable of surviving. It is necessary to check this sick pen several times a day. To improve the movement of sick animals, it is recommended to set up a sick pen at each end of the barn so as to avoid long distances through the turkey barn, especially for heavy, older animals (Krautwald-Junghanns, 2003).

The Bundeseinheitliche Eckwerte (2013) [Germany Voluntary Benchmarks] contain the following text: If animals should not appear healthy, or if they have difficulty walking, are injured or show behavioural traits such as feather pecking, excessive aggressiveness or cannibalism, the keeper must take immediate steps to determine the cause, apply remedial measures. The monitoring of the flock should be intensified if necessary. If the measures taken by the keeper are not effective, a veterinarian must be consulted and, if necessary, expert advice on other relevant factors sought. If the cause is due to an environmental factor in the production unit which cannot be rectified immediately, this should be done when the barn is vacated and before the next group of animals is housed. Injured, sick or suffering animals must be cared for immediately and with special attention and, if necessary, housed separately from the rest of the flock. Easily accessible sick compartments must be available for this purpose or be able to be set up immediately if necessary. These must be well ventilated and equipped with easily accessible feeding bowls and drinking troughs. The partition of the sick pen must be stable and its area must be extendable if necessary (Bundeseinheitliche Eckwerte, 2013).

For a detailed list on how to prevent feather pecking and cannibalism in turkeys as well as emergency measures if they should occur, see the recommendations of the Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz (NMELV, 2019b) [Lower Saxony Ministry of Food, Agriculture and Consumer Protection].

The costs incurred for intensive animal care that are also necessary when cannibalism occurs in the flock are difficult to assess in this context. They depend in part also on location factors specific to the farm and qualified labour (Strüve et al., 2016a,b).

4.4.4 Occupational material

Turkeys are curious animals. Even poults peck at shiny small objects that contrast with the background. Occupational opportunities should therefore be provided to counteract the lack of stimuli in the environment.

Various programmes (e.g. Bundeseinheitliche Eckwerte, Beter Leven, Neuland) already require or quantify occupational material (e.g. one such enrichment item per 1000 birds in Beter Leven).

The advantages of such material comprise in particular:

- Exercise of normal (exploratory) behaviour
- Reduction of injurious pecking by redirecting the pecking behaviour.

The type of occupational material can be chosen freely, but it must be provided in sufficient quantity and in rotation. An increase in working time per animal is bound to ensue. Newly introduced litter material is considered as occupational. According to the Bundeseinheitliche Eckwerte (2013) [Germany Voluntary Benchmarks] for instance, at least one other workable material must be offered, such as straw/hay in piles, straw bales or other pickable objects such as picking blocks. The enrichment items should be evenly distributed in the barn. At least 1 object per 400 m² of usable barn area or part thereof should be provided.

In order to cater for the animals’ pecking and exploring instincts, other occupational possibilities were also used, such as carrots suspended in a net, bales of straw raised on the walls, etc. Some farmers put small plastic plates, maize silage and the like in the barns in addition to the litter when there are frequent cases of injurious pecking. These additional objects are not available to the animals during the entire rearing and fattening periods however (Letzguß, 2010). Other occupational materials can include reflective metal foils, CDs, chains, strings, cloth objects, plastic plates, containers, bottles, cones, balloons, hay baskets, “pecking stones” and pumpkins (Frackenpohl and Meyer, 2005).

According to the recommendations of the Lower Saxony Ministry of Agriculture, Food and Consumer Protection (NMLEV, 2019a), the “materials used must not lead to any adverse health effects on the animals, i.e. there must be no injuries, infections or poisoning when they ingest or ‘work on’ the materials provided.” The occupational materials provided must also be harmless from the point of view of food hygiene as well as feed legislation. It should be noted that occupational items provided on the floor, which can be ingested by the animals, are consumed particularly quickly and thus may not be suitable for a longer-term occupation of the animals. The animals may be interested in an occupational material for a longer period of time if the turkeys have to “work on it”.

Health aspects: Various authors have looked at occupational options for turkeys, especially from the point of view of avoiding injurious pecking (e.g. Crowe and Forbes, 1999, Martrenchar, 2001, Frackenpohl and Meyer, 2005). The results are partly contradictory. For example, according to a report by Wageningen University for the EFSA on the keeping of animals for farming purposes (Wageningen, 2010), different types of environmental enrichment did not have a major influence on pecking behaviour.

There are several positive findings from other investigators, however. Martrenchar et al. (2001) investigated the influence of environmental enrichment (metal objects and straw) on pecking in young turkeys. Aggressive pecking was observed more frequently without enrichment and the conclusion was drawn that metal objects and straw reduce harmful pecking in young female and male turkeys by redirecting pecking.

Furthermore, in another experiment, Martrenchar et al. (2001) provided Big 9 turkeys with four reflective galvanised iron sheets (15 cm x 20 cm, with 10 holes) suspended in a free-swinging manner with metal chains. In addition, straw bales were provided; there was excessive consumption of these at the end of the experiment. On the whole, however, the authors rated the groups with environmental enrichment in significantly more positive terms for reduction in aggressive feather pecking, improvement in plumage and reduction in skin wounds.

In a study by Sherwin et al. (1999b), for example, straw was provided as coarsely cut wheat straw (2 kg/room) starting on day 3 and renewed every 5 to 6 days. The straw bales were fixed along the barn wall, whereby feather pecking could be significantly reduced in conjunction with other measures. This was also seen by Huesmann (2008), where studies on the occupational elements used (straw bales and hay baskets) showed a decrease in object pecking during the fattening process as the age of the turkeys increased.

In a further experiment by Berk et al. (2014), only occupational materials that were either edible or released feed when the turkeys worked on them were used twice a week. In this way, the distraction away from conspecifics to pecking at substitute objects was to receive positive reinforcement by “rewarding” the birds with food grains or other edible substances. This has not yet led to a full reduction of injurious pecking to the desired extent, however. The relatively small group size and the high stocking densities of 52 kg/m² (hens) and 58 kg/m² (toms) have to be taken into account, nonetheless. The effects of the comparatively small compartment size (18 m²) and the lack of shelter should also be taken into account here, as the “target” animal always remained in the sights of the chasing group (Berk et al., 2014). It is unclear, therefore, to what extent the results of this study can be transferred to large conventional stables.

Use: In a model project by the Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL) [Association for Technology and Structures in Agriculture] entitled “Tiergerechte Mastputenhaltung mit Beschäftigungs- und Strukturelementen” [Animal-friendly fattening turkey husbandry with occupational and structural elements] (Spindler et al., 2007, funded by the German Federal Ministry of Food, Agriculture and Consumer Protection), the effects of structural (see point 3.2) and occupational elements (straw bales/hay baskets) were investigated in 2 conventional and 3 organic turkey farms during fattening and at the slaughterhouse. In principle, all the elements deployed were used by the turkeys. Since no significant injurious pecking occurred in the barns, the influence of the elements on this behaviour could not be tested. Letzguß stated in 2010 that at least 10% of the turkeys examined in the area of the round straw bales were either directly occupied with the round bale or were pecking in the environment (already loose straws of the round bale in the litter) and that these were consistently well accepted. Towards the end of the fattening period, even a percentage increase was observed. Cottin (2004) also confirms that the straw bales used were well accepted as occupational material and a place to sit until the end of the fattening period. Also in an experiment by Berk et al. (2014), the occupational materials used twice a week, which were either edible or released feed when worked by the turkeys (pecking blocks, feed dispensers filled with wheat grains, wheat extrudate and crispbread), were very well accepted and used by turkeys of both sexes.

Occupational materials that have proven to be of lasting interest to turkeys include (NMELV, 2019a):

- Hay or straw in baskets or nets (prerequisite: straw or hay of good quality; provided from ca. the 7th week of life; grit must also be provided to prevent gastric congestion);
- Straw bales (see structuring elements); grit must also be offered to prevent gastric congestion;
- Pecking blocks: Pecking blocks whose basic substance is enriched with coarse-grained additives (grains, oyster shells, etc.) have proven to be particularly attractive for turkeys. Pecking blocks are available in different degrees of hardness. They must not be too hard so that they can be handled and "consumed" by the turkeys. If pecking blocks are provided in plastic containers, "windows" should be cut into the containers to make them more attractive to the birds. "To be provided as of ca. the 2nd week of life; grain given via feed dispensers/feeders; quantity: recommended is at least 1 occupational material as of the 2nd or 3rd week of life for 2,000 animals; from the 6th week of life for 400-500 animals." (NMELV, 2019a).

4.5 Comments on the knowledge and skill requirements for people who keep or have to care for turkeys

The various structural specifications for more animal-friendly turkey husbandry cannot replace daily animal observation and assessment of the conditions by dedicated expert personnel. In addition to the expertise of the people caring for the animals, significant differences in animal husbandry can be seen depending on the commitment and relationship of the staff to the animals they attend to. All people in contact with the animals should have a demonstrable knowledge and ability in the welfare of the animals in their care (Council of Europe Recommendations, 2001). The animal caretakers themselves must have demonstrable training in agriculture or animal husbandry (which sometimes varies widely in different training institutions) with specific knowledge in poultry management. All keepers should attend appropriate short courses at least once or twice a year (Krautwald-Junghanns, 2003), and certificates of attendance must be provided. Apart from an improvement in the quality of work, which is undoubtedly achieved by the aspect of a better understanding of the animals entrusted to them, incentives for the caring staff should also be of a financial nature (e.g. percentage share, performance bonuses).

4.5.1 Expertise

In a draft ordinance amending the Ordinance on the Protection of Animals and Keeping of Animals for Farming Purposes (Bundesrat, 2015), the German Federal Council stipulated that only those holding a valid certificate of competence may keep or care for fattening turkeys.

In this respect, the Bundeseinheitliche Eckwerte (2013) [German Voluntary Benchmarks] stipulate the following:

All animal keepers who are active in turkey husbandry must prove their expert knowledge. Proof of expertise shall be deemed to be provided if:

a) a training programme in animal husbandry professions with specialisation in poultry or in farming has been successfully completed; or
b) a course of study in agricultural sciences or veterinary medicine has been successfully completed; or
c) a turkey flock of no fewer than 500 turkeys has been kept under a veterinary flock management contract for at least three years under the applicant’s own responsibility and without any objections pursuant animal welfare law; the authority reserves the right to have the expert knowledge proven in individual cases by means of an expert interview; or
d) the applicant demonstrates knowledge and skills in the field of animal-friendly turkey husbandry. The aim is to obtain a certificate of competence recognised by the authorities.

The expertise comprises the following topics:

As regards knowledge:

- legal regulations, in particular on animal welfare and animal health legislation
- basic knowledge of turkey anatomy and physiology
- basic knowledge of turkey behaviour, indicators of behavioural disorders
- supplying turkeys with feed and water according to their needs
- signs of health disorders in turkeys and possible countermeasures
- dealing with sick and injured turkeys in accordance with animal welfare requirements
- appropriate stunning and culling of turkeys in accordance with animal welfare requirements
- basic knowledge of turkey husbandry and the process technology required for it
- hygiene and disinfection

As regards skills:

- handling turkeys in a manner appropriate to animal welfare
- catching, loading and transporting turkeys in a manner appropriate to animal welfare
- proper stunning and killing in accordance with animal welfare requirements

In a nationwide survey conducted in Germany, the 24 turkey fattening farms visited were run predominantly by appropriately trained keepers (agricultural or animal husbandry training, graduate agricultural engineer, veterinarian). In more than one third of the cases, however, the daily care of the fattening animals was not provided by appropriately qualified personnel, but by semi-skilled workers who by their own admission had no appropriate training (Krautwald-Junghanns et al., 2009a).

Further training: All those who keep or care for turkeys must prove to the competent authority that they have taken part in specialist training measures for at least three hours at least once a year. Participation must be documented and presented to the competent authority upon request (BMELV, 2015).

Turkey keepers shall participate regularly in relevant training measures. The updated expertise shall be documented at least every five years. Proof thereof must be presented to the competent authority on request (Bundeseinheitliche Eckwerte, 2013).

Pursuant to the circular of the Ministry (NMELV, 2019b), all Lower Saxon turkey farmers are already to prove that the debeaking of their flock is temporarily indispensable. This requires, among other things, that turkey farmers attend training courses in the current year on the “Recommendations to prevent the occurrence of feather pecking and cannibalism” (NMELV, 2019a) which were developed in the Animal Welfare Plan. The Lower Saxony Chamber of Agriculture offers corresponding training dates in cooperation with other institutions, and the contents are recognised by the NMELV.

Bibliography

The expert report included in particular:

- citable scientific primary literature,
- dissertations that have been reviewed by several scientists,
- studies by scientific institutions, which were usually commissioned by ministries/research communities,
- texts from conference reports that were based on scientific research.

It was also necessary to draw on unverifiable information from reference books, industry and internet research in Sections 1 and in particular. In addition, recommendations from expert committees were included.

The search engines Pubmed, Google Scholar and ResearchGate were used, among others for bibliographical research purposes.

In contrast to countries outside the German-speaking world, it was also possible to access scientific research projects (often final reports for ministries) and dissertations due to the authors' activities in various committees.

A

Abbott WW, Couch JR, Atkinson RL. The incidence of foot-pad dermatitis in young turkeys fed high levels of soybean meal. Poultry Sci. 1969;48:2186-2188.

Abdel-Rahman MA. Study on the effect of stocking density and floor space allowance on behaviour, health and productivity of turkey broilers. Assiut. Vet. Med. J. 2005:51(104):1-13.

Abd El-Wahab A. Experimental studies on effects of diet composition (electrolyte contents), litter quality (type, moisture) and infection (coccidia) on the development and severity of foot pad dermatitis in young turkeys housed with or without floor heating [Dissertation med. vet]. Hannover: Tierärztliche Hochschule. 2011.

Abd El-Wahab A, Beineke A, Beyerbach M, Visscher CF, Kamphues J. Effects of floor heating and litter quality on the development and severity of foot pad dermatitis in young turkeys. Avian Dis. 2011;55(3):429–434.

Abd El-Wahab A, Visscher CF, Beineke A, Beyerbach M, Kamphues J. Experimental studies on the effects of different litter moisture contents and exposure time to wet litter on development and severity of foot pad dermatitis in young fattening turkeys. Archiv für Geflügelkunde. 2012;76(1):55–62.

Achilles W, Huesmann K, Spindler B, Letzguß H. Beschäftigungs- und Strukturelemente in der Mastputenhaltung. VetJournal. 2013; 10: 30-37

Andersson R, Toppel K. Identifizierung und Erprobung von Parametern zur Indikatorbildung und als Instrument des Controllings – mit Fokus auf Mortalität, Fußballengesundheit, Arzneimitteleinsatz. Abschlussbericht. Osnabrück: Hochschule Osnabrück, Fakultät Agrarwissenschaften und Landschaftsarchitektur, Fachgebiet Tierhaltung und Produkte. 2014.

Appleby, Michael C., Joy A. Mench, and Barry O. Hughes. Poultry behaviour and welfare. Oxfordshire: Cabi, 2004.

Aviagen Turkeys. Management – Richtlinien zur Aufzucht von Mastputen. 2017.URL: https://www.aviagenturkeys.com/uploads/2017/08/23/CL23 (downloaded on 2.11.2020).

Aviagen Turkeys. Products. Aviagen Group. 2017. URL: https://www.aviagenturkeys.com/de-de/products (downloaded on 29.10.2020)

B

Baboo I, Javid A, Asraf M, Mahmud A. Time-Budgets of Turkeys (Meleagris gallopavo) reared under confinement and free-range rearing systems. Pakistan Journal of Zoology 2016; 48(6):1951-1956

Bachmann K., Frosch W. Ratgeber für Stallklimatisierung, Sächsisches Landeskuratorium Ländlicher Raum e.V. 2008:9–13.

Bakst MR, Cecil HC. Gross appearance of turkey cloacae before and after single or multiple manual semen collections. Poultry science. 1983;62(4):683-9.

Bakst MR, Dymond JS. Success in Artificial Insemination-Quality of Semen and Diagnostics Employed. Artificial insemination in poultry. IntechOpen. 2013: 722-3.

Barber CL, Prescott NB, Wathes CM, Le Sueur C, Perry GC. Preferences of growing ducklings and turkey poults for illuminance. Animal Welfare 2004;13(2):211-224.

Barber CL, Prescott NB, Jarvis JR, Le Sueur C, Perry GC, Wathes, CM. Comparative study of the photopic spectral sensitivity of domestic ducks (Anas platyrhynchos domesticus), turkeys (Meleagris gallopavo gallopavo) and humans. Br Poult Sci. 2006;47(3):365-374.

Bartels T, Lütgeharm JH, Wähner M, Berk J. UV reflection properties of plumage and skin of domesticated turkeys (Meleagris gallopavo f. dom.) as revealed by UV photography. Poult Sci. 2017;96 (12):4134-4139.

Bartels T, Huchler M, Freihold D, Thieme S, Bergmann S, Berk J, Cramer K, Deerberg F, Dressel A, Erhard M, Ermakow O, Pees M, Spindler B, Hafez H, Krautwald-Junghanns M-E. Examinations on the prevalence of foot pad alterations in fattening turkeys reared in organic production systems and on some selected factors potentially affecting foot pad condition. Berliner und Münchner Tierärztliche Wochenschrift. 2020a.

Bartels T, Stuhrmann RA, Krause ET, Schrader L. Research Note: Injurious pecking in fattening turkeys (Meleagris gallopavo f. dom.)-video analyses of triggering factors and behavioral sequences in small flocks of male turkeys. Poult Sci. 2020b.

Bartz, BM. The effects of LED lighting and the identification of the AgRP feeding mechanism in turkey hens [PhD thesis]. North Carolina, Graduate Faculty of North Carolina State University. 2020.

Beaulac K, Schwean-Lardner K. Assessing the effects of stocking density on turkey tom health and welfare to 16 weeks of age. Front. Vet. Sci. 2018:213.

Beaulac K, Classen HL, Gomis S, Sakamoto KS, Crowe TG, Schwean-Lardner K. The effects of stocking density on turkey tom performance and environment to 16 weeks of age. Poult Sci. 2019;98(7):2846-2857.

Bellof G, Brandl M, Schmidt, E. Schlussbericht Forschungsprojekt Nr. 03OE234 – Ökologische Putenmast: Abstimmung von Genotyp, Haltung und Fütterung. 2010. URL: https://orgprints.org/18771/ (downloaded on 29.10.2020).

Bellof G, Brandl M, Schmidt E, Carrasco S, Schade B. Effect of different feeding intensity and housing condition on growth performance and carcass yield of slow- or fast-growing genotypes in organic turkey production. European Poult Sci. 2014:78.

Bennett ATD, Cuthill IC. Ultraviolet vision in birds: What is its function? Vis. Res. 1994; 34:1471–1478.

Berg CC. Foot-pad dermatitis in broilers and turkeys–Prevalence, risk factors and prevention. [PhD thesis] Swedish Univ. Agric. Sci., Uppsala, Sweden. 1998.

Bergmann S. Vergleichende Untersuchung von Mastputenhybriden (B.U.T. Big 6) und einer Robustrasse (Kelly Bronze) bezüglich Verhalten, Gesundheit und Leistung in Freilandhaltung [Dissertation med. vet.] München: Ludwig-Maximilians-Universität-München. 2006.

Bergmann S, Ziegler N, Bartels T, Hübel J, Schumacher C, Rauch E, Brandl S, Bender A, Casalicchio G, Krautwald-Junghanns M-E, Erhard M. Prevalence and severity of foot pad alterations in German turkey poults during the early rearing phase. Poult Sci. 2013; 92:1171-1176.

Berk, J. Keeping and management during rearing and fattening in turkeys. European Poult Sci. 1999;63(2):52-58.

Berk J, Hahn G. Aspects of animal behaviour and product quality of fattening turkeys influenced by modified husbandry. Archiv Tierzucht Dummerstorf. 2000;43:189–195.

Berk, Jutta. Artgerechte Mastputenhaltung: baulich-technische Ansätze zur Verbesserung der Haltungsumwelt. KTBL-Schrift, 2002.

Berk J, Hinz T. Behaviour and welfare of tom turkeys under enriched husbandry conditions. Ann Anim Sci. 2002;1:35–37.

Berk J, Wartemann, S, Feldhaus L, Hinz T, Linke S. Praxisuntersuchung zum Einsatz eines Außenklimabereiches in der Putenmast als Pilotprojekt in Deutschland. KTBL-Schriften-Vertrieb im Landwirtschaftsverlag, Münster. 2003.

Berk J, Wartemann S. Einfluss eines Putenmaststalles mit Außenklimabereich auf Leistung, Verhalten und Gesundheit von männlichen Puten. Dtsch Tierärztl Wschr. 2006;113:107-110.

Berk J. Effekte der Einstreuart auf Tiergesundheit und Tierleistungen bei Putenhennen. In: Rahmann G, Schumacher U, Hrsg. Neues aus der Ökologischen Tierhaltung. 2009a.;332:23–29.

Berk J. Effects of different types of litter on performance and pododermatitis in male turkeys. Proceedings of the 5th International Symposium on Turkey Production, Meeting of the Working Group 10 (Turkey) Berlin: Mensch-und-Buch-Verlag. 2009b:127–134.

Berk J. Putenmast – Haltung und Management. KTBL-Schrift, Darmstadt. 2009c.

Berk J, Hinz T. Effect of litter type on health, performance and air quality in a forced ventilated turkey house. Proceedings of the 8th International Symposium on Turkey Diseases. Berlin: Mensch-und-Buch-Verlag. 2010:43–50.

Berk J, Kirchner J. Was bringt ein Außenklimabereich? DGS Magazin für Geflügelwirtschaft? 2011;39:31-36.

Berk J. Einfluss der Besatzdichte auf Tierverhalten und Tiergesundheit bei Putenhennen mit Zugang zu einem Außenklimabereich. Aktuelle Arbeiten zur artgemäßen Tierhaltung. KTBL-Schrift, Darmstadt. 2011;489:162-169.

Berk J. Behaviour and health of different turkey genotypes with outdoor ascess. Proceedings of the 47th congress of the International Society for Applied Ethology, Wageningen Academic Publishers. 2013a:102.

Berk J, Schumacher C, Krautwald-Junghanns M-E, Martin M, Bartels T. Verweildauer von Mastputen verschiedener Herkünfte im Bereich von Tränke- und Fütterungseinrichtungen. Landbauforschung. Applied Agricultural and Forestry Research. 2013b;63(3):245–254.

Berk J, Stehle E, Bartels T. Einfluss des Angebotes von Beschäftigungsmaterial und der Verabreichung phytogener Trinkwasserzusätze auf die Prävalenzen von Federpicken und Kannibalismus bei nicht-schnabelgekürzten Puten, Abschlussbericht. Institut für Tierschutz und Tierhaltung Celle. 2014.

Berk J, Stehle E, Bartels T. Beschäftigungsmaterial – eine Möglichkeit zur Reduktion von Beschädigungspicken bei Mastputen mit unkupierten Schnäbeln? Berliner und Münchener Tierärztliche Wochenschrift. 2017;130(5/6):230–240.

Bessei, W. Das Verhalten von Mastputen – Literaturübersicht. Archiv für Geflügelkunde. 1999;63(2):45–51.

Bessei W. Welfare of broilers: a review. World Poult Sci J. 2006;62:455-466.

Bessei W, Günther P. The behavior of turkeys in response to increasing stocking density and to different litter material. Proceedings of the 8th International Symposium on Turkey Diseases. Berlin: Mensch-und-Buch-Verlag. 2005:90-100

Bessei W, Günther P. Drinking behaviour in growing turkeys. Proceedings of the 6th international symposium on turkey diseases, Berlin, Gießen: DVG-Verlag. 2006;34–48.

Bircher L, Schlup P. Schlussbericht Teil 1 – Das Verhalten von Truten eines Bauernschlages unter naturnahen Haltungsbedingungen. Abteilung Sozial- und Nutztierethologie, Zoologisches Institut, Universität Bern, 1991 a.

Bircher L, Schlup P. Schlussbericht Teil 2 – Ethologische Indikatoren zur Beurteilung der Tiergerechtheit von Trutenmastsystemen. Abteilung Sozial- und Nutztierethologie, Zoologisches Institut, Universität Bern, 1991 b.

Bircher L., Schlup P., Stauffacher M.: Auswirkungen des Schnabelcoupierens auf das Verhalten von Masthybrid-Truten. BVET, Bern, 1991c.

Bircher L, Hirt H, Oester H. Sitzstangen in der Mastputenhaltung. In: Aktuelle Arbeiten zur artgemäßen Tierhaltung, KTBL-Schrift, Darmstadt. 1995;373:169–177.

Bircher L, Hirt H, Oester H. Provision of perches for intensively-reared turkeys. Aktuelle Arbeiten zur artgemäßen Tierhaltung, KTBL Schrift.1996;373:169-177

Block H. Vor – und Nachteile der Fußbodenheizung in Geflügelmastanlagen. Proceedings 81. und 82. Fachgespräch über Geflügelkrankheiten. Hannover. Giessen: DVG Verlag. 2012;17-18.

BMEL. Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMEL), Deutschland. Vereinbarung zur Verbesserung des Tierwohls, insbesondere zum Verzicht auf das Schnabelkürzen in der Haltung von Legehennen und Mastputen. 2015.

Bosse H, Meyer H. Different methods for turkey-rearing. Proceedings of the 4th international symposium on turkey production, meeting of the working group 10 (turkey); Berlin: Mensch-und-Buch-Verlag. 2007;123–127.

Bozakova N, Oblakova M, Stoyanchev K, Yotova I, Lalev M. Ethological aspects of improving the welfare of turkey breeders in the hot summer period by dietary L-arginine supplementation. Bulg. J. Vet. Med. 2009;12(3):185-191.

Brant AW. A brief history of the turkey. World's Poult Sci J. 1998;54(4):365-373.

Buchwalder, T., Huber-Eicher, B. A brief report on aggressive interactions within and between groups of domestic turkeys (Meleagris gallopavo). Appl. Anim. Behav. Sci. 2003; 84,75-80.

Buchwalder T, Huber-Eicher B. Effect of increased floor space on aggressive behaviour in male turkeys (Meleagris gallopavo). Appl Anim Behav Sci. 2004;89:207–214.

Buchwalder T. Huber-Eicher B. Effect of group size on aggressive reactions to an introduced conspecific in groups of domestic turkeys (Meleagris gallopavo). Appl. Anim. Beh. Sci. 2005;93:251-258.

Buchwalder T, Huber-Eicher B. A brief report on aggressive interactions within and between groups of domestic turkeys (Meleagris gallopavo). Appl Anim Behav Sci. 2013;84:75–80.

Bundeseinheitliche Eckwerte für eine freiwillige Vereinbarung zur Haltung von Mastputen. Verband deutscher Putenerzeuger e.V., 2013.

Bundesrat, Entwurf einer Verordnung zur Änderung der Tierschutz-Nutztierhaltungsverordnung, Verordnungsantrag vom 30. Juni 2015.

Burkhardt D. Birds, berries and UV. Naturwissenschaften 1982; 69 (4):153-157.

Burkhardt D. UV vision: a birds view of feathers. J. Comp. Physiol. 1988;64:787-96.

Burkhardt D. UV vision: a bird's eye view of feathers. Journal of Comparative Physiology A. 1989;164(6):787-96.

Busayi RM, Channing CE, Hocking PM. Comparisons of damaging feather pecking and time budgets in male and female turkeys of a traditional breed and a genetically selected male line. Appl. Anim. Beh. Sci. 2002;96(3–4):281–292.

Busayi R, Channing C, Hocking P. Comparisons of damaging feather pecking and time budgets in male and female turkeys of a traditional breed and a genetically selected male line. Appl Anim Behav Sci.2006;96:281-292.

C

Callait-Cardinal MP, Gilot-Fromont E, Chossat L, Gonthier A, Chauve C, Zenner L. Flock management and histomoniasis in free-range turkeys in France: description and search for potential risk factors. Epidemiol Infect. 2010;138(3):353-63.

Çapar AH, Onbaşilar EE. Light wavelength on different poultry species. World's Poult Sci J. 2018;74(1):79-88.

Cathey J, Melton K, Dreibelbis J, Cavney B, Locke S, DeMaso S, Schwertner WT, Collier B. Rio Grande wild turkey in Texas: biology and management. Texas Farmer Collection. 2007.

Charles, D, Payne C. The influence of graded levels of atmospheric ammonia on chickens: I. Effects on respiration and on the performance of broilers and replacement growing stock. British Poultry Science 7, 1966;3: 177-187.

Chuppava B. Effects of different flooring designs on the performance and foot pad health and on the development of antimicrobial resistance in commensal Escherichia coli in broiler and turkey production. [Dissertation med. vet.], Hannover: Tierärztliche Hochschule. 2018.

Clark S, Hansen G, McLean P, Bond Jr P, Wakeman W, Meadows R, and Buda S. Pododermatitis in turkeys. Avian Diseases 2002;46 (4): 1038-1044..

Classen HL, Riddell C, Robinson FE, Shand PJ, McCurdy A. Effect of lighting treatment on the productivity, health, behaviour and sexual maturity of heavy male turkeys. Brit. Poult. Sci. 1994;35:215-225.

Coleman J, Leighton A. The effect of population density on the production of market turkeys. Poult Sci. 1969;48(2):685-693.

Commision internationale de genie rural. Climatization of animal houses. Second report of a working group. Centre for Climatization of Animal Houses. State University of Ghent, Belgium. 1992:147.

Cottin E. Einfluss von angereicherter Haltungsumwelt und Herkunft auf Leistung, Verhalten, Gefiederzustand, Beinstellung, Lauffähigkeit und Tibiale Dyschondroplasie bei männlichen Mastputen. [Dissertation med. vet.], Hannover: Tierärztliche Hochschule. 2004.

Crowe R, Forbes J. Effects of four different environmental enrichment treatments on pecking behaviour in turkeys. Brit Poultry Sci. 1999;40(S11): 11-12.

D

Da Costa M, Grimes J, Oviedo E, Shah S, Barasch I, Evans C, et al. Current challenges and opportunities for turkey flock management: foot pad health and ventilation. Proceedings of the 7th „Hafez“ International Symposium on Turkey Production, meeting of the Working Group 10 (Turkey) of WPSA; Berlin: Mensch-und-Buch-Verlag; 2013:99–105.

Da Costa M, Grimes J, Oviedo-Rondon E, Barasch I, Evans C, Dalmagro M, et al. Foot pad dermatitis severity on turkey flocks and correlations with locomotion, litter conditions, and body weight at market age. J Appl Poult Res. 2014;23(2):268–279.

Dalton H, Wood B, Torrey S. Injurious pecking in domestic turkeys: Development, causes, and potential solutions. World's Poult Sci J. 2013;69:865–876.

Dalton H, Wood B, Widowski T, Guerin M, Torrey S. Changes in leg health, skin, and plumage condition in domestic male turkeys of varying body weights. Appl. Anim. Beh. Sci. 2016;178: 40-50.

Dalton H. The relationships between the performance of injurious pecking and behavioural and physical traits in domestic turkeys. [PhD thesis]. Guelph: Universität Guelph. 2017.

Dalton H, Wood B, Widowski T, Guerin T, Torrey S. Comparing the behavioural organization of head pecking, severe feather pecking, and gentle feather pecking in domestic turkeys. Appl. Anim. Beh. Sci. 2018;204(2):66-71.

Damme K, Urselmans S. Infrared beak treatment-a temporary solution?. Lohmann Information. 2013;48(2):36-44.

Day K, Lester D, Tucker W. Characteristics of wild turkey nest sites in a mixed-grass prairie–oak–woodland mosaic in the northern great plains, South Dakota. Canadian Journal of Zoology 1991;69 (11):2840-2845.

DEFRA. Department for Environment Food & Rural Affairs. Guidance Turkeys: welfare recommendations. Updated 5 July 2019: https://www.gov.uk/government/publications/poultry-on-farm-welfare/turkeys-welfare-recommendations.

Denbow D, Leighton A, Hulet R. Behaviour and growth parameters of Large White Turkeys as affected by floor space and beak trimming. 1. Males. Poult Sci. 1984;63:31-37

Denbow D, Leighton A, Hulet R. Effect of light sources and light intensity on growth performance and behaviour of female turkeys. Br Poult Sci. 1990;31(3):439-445.

Deutscher Tierschutzbund e.V. Puten. http://www.tierschutzbund.de, downloaded on 25.10.2020

Dillier R M. Ethologische Indikatoren zur Beurteilung der Tiergerechtheit intensiver Aufzuchthaltungen für die Mastproduktion von Puten. Schlußbericht für das Bundesamt für Veterinärwesen, Bern. 1991

Mac Donald AM, Jardine CM, Rejman E, Barta JR, Bowman J, Cai HY, Susta L, Nemeth NM. High Prevalence of Mycoplasma and Eimeria species in free-ranging Eastern Wild Turkeys (*Meleagris gallopavo silvestris*) in Ontario, Canada. J Wildl Dis. 2019;55(1):54-63.

Duggan G, Widowski T, Quinton M, Torrey S. The development of injurious pecking in a commercial turkey facility. J Appl Poult Res. 2014;23:1–11.

E

Earl J, Brenneman M, Kennamer R. History of the Wild Turkey in North America. National Wild Turkey Federation, Wildlife Bulletin. National Wild Turkey Federation. Edgefield. 1990;15.

EG-Verordnung (EG) Nr. 834/2007 vom 28. Juni 2007 über die ökologische/biologische Produktion und die Kennzeichnung von ökologischen/biologischen Erzeugnissen und zur Aufhebung der Verordnung (EWG) Nr. 2092/91 (ABl. Nr. L 189 vom 20. Juli 2007 und ABl. Nr. L 162 vom 21. Juni 2012)

Ekstrand C, Algers B. Rearing conditions and foot-pad dermatitis in swedish turkey poults. Acta Vet. Scand. 1997;38(2):167–174.

Ellerbrock S, Knierim U. Static space requirements of male meat turkeys. Veterinary Rec. 2002;151,(2):54-57.

Ellerbrock S. Beurteilung verschiedener Besatzdichten in der intensiven Putenmast unter besonderer Berücksichtigung ethologischer und gesundheitlicher Aspekte. [Dissertation med. vet.]. Hannover: Tierärztliche Hochschule Hannover; 2002.

Ellerich R. Prävalenz von Veränderungen der Haut und ihrer Anhangsorgane bei Mastputen [Dissertation med. vet.]. Leipzig: Universität Leipzig; 2012.

Erasmus MA. A review of the effects of stocking density on turkey behavior, welfare, and productivity. Poult Sci. 2017;96(8):2540-2545.

Erasmus MA. Welfare issues in turkey production. Advances in Poultry Welfare 2018; 264-291.

Engelmann C. Das Verhalten des Geflügels. In: Scholtyssek S, Doll P, Hrsg. Nutz – und Ziergeflügel. Stuttgart: Ulmer; 1978:86–105.

Enueme J, Waibel P, Farnham, R. Use of peat as a bedding material and dietary component for tom turkeys. Poult Sci. 1987;66(9):1508–16.

Ermakow O. Ergebnisse der Fleischuntersuchung bei Puten aus ökologischer und konventioneller Haltung [Dissertation med. vet], Leipzig: Universität Leipzig; 2012.

Europarats-empfehlungen, Europäisches Übereinkommen zum Schutz von Tieren in landwirtschaftlichen Tierhaltungen – Empfehlung in Bezug auf Puten (Meleagris gallopavo ssp.) vom 21. Jun. 2001. BAnz. S. 4743

Europäische Kommission, Richtlinie 98/58/EG des Rates vom 20. Juli 1998 über den Schutz landwirtschaftlicher Nutztiere in der Fassung der Bekanntmachung vom 08. August 1998, zuletzt geändert durch die Verordnung (EU) Nr. 806/2003 des Rates vom 14. April 2003. 1998. ABl. EG. L 221 S. 23.

EU-Kommission. Verordnung (EG) Nr. 889/2008 zur Verordnung (EG) Nr. 834/2007 des Rates über die ökologische/biologische Produktion und die Kennzeichnung von ökologischen/biologischen Erzeugnissen hinsichtlich der ökologischen/biologischen Produktion, Kennzeichnung und Kontrolle. 2008.

EU-Verordnung (EU) 2018/848 vom 30. Mai 2018 über die ökologische/biologische Produktion und die Kennzeichnung von ökologischen/biologischen Erzeugnissen sowie zur Aufhebung der Verordnung (EG) Nr. 834/2007 des Rates (ABl. Nr. 150 vom 14. Juni 2018)

F

Farm Animal Welfare Council (FAWC). [ARCHIVED CONTENT] UK Government Web Archive – The National Archives FAWC report on the welfare of turkeys. 1995.

Farm Animal Welfare Council (FAWC). FAWC Report on farm animal welfare in Great Britain: past, present and future. 2009:1–70.

Feldhaus L, Sieverding E. Klimabedingungen. In: Feldhaus, L. und Sieverding, E, Hrsg. Putenmast. Stuttgart: Verlag Eugen Ulmer. 2001:24.

Feldhaus L, Sieverding E. Putenmast. Stuttgart: Verlag Eugen Ulmer; 2007:1-97.

Ferrante V, Estevez I. The Animal Welfare Indicators (AWIN) project meets the stakeholders to ensure the acceptability of on-farm turkey welfare assessment. Proceedings of the 7th „Hafez“ International Symposium on Turkey Production, meeting of the Working Group 10 (Turkey) of WPSA; Berlin: Mensch-und-Buch-Verlag; 2013:33–8.

Felts J, Leighton A, Denbow D, Hulet R. Influence of light sources on the growth and reproduction of large white turkeys. Poult Sci. 1990;69(4):576-583.

Fiedler HE, König K. Tierschutzrechtliche Bewertung der Schnabelkürzung bei Puteneintagsküken durch Einsatz eines Infrarotstrahls. Arch. Geflügelk. 2006;70:241-249.

Finger E, Burkhardt D. Biological aspects of birds colouration and avian colour vision including ultraviolet. Vision Res. 1994(34):1509-14.

Flüchten A. Epidemiologische Untersuchungen zum Auftreten und zu den betriebsspezifischen Faktoren der Clostridium perfringens-Infektion der Pute. [Dissertation. med. vet.], Hannover: Tierärztlichen Hochschule Hannover. 2006.

Frackenpohl U. Sommerlüftung im Putenstall – "Cool" bleiben trotz Hitzestress. DGS Magazin 2003;23:29-35.

Frackenpohl, U., Meyer H. "Feather pecking and cannibalism: practical experiences to keep turkeys busy." Animal Science Papers and Reports. Supplement 23. 2005 (1).

Freihold D, Bartels T, Bergmann S, Berk J, Deerberg F, Dressel A, Erhard M, Ermakow O, Huchler M, Krautwald-Junghanns M-E, Spindler B, Thieme S., Hafez H. Investigation of the prevalence and severity of foot pad dermatitis at the slaughterhouse in fattening turkeys reared in organic production systems in Germany. Poult. Sci. Assoc. Inc. 2018:1559-1567

G

Gentle MJ, Thorp BH, Hughes BO. Anatomical consequences of partial beak amputation (beak trimming) in turkeys. Research in Veterinary Science. 1995;58(2):158-62.

Geraedts L. Leg disorders caused by litter conditions and the influence of the type of litter and of litter cultivations on the results of turkeys. Turkeys. 1983;31(5):20–5.

Gesellschaft Zukunft Tierwohl. Richtlinien zur Haltung von Puten nach dem Standard „Tierwohl verbesser“, Ebene Landwirtschaft. 2018. http://www.zukunfttierwohl.at/wp-content/uploads/2019/07/GZT-LV-Rili-Puten (downloaded on 10.11.2020).

Gill D, Leighton A. Effects of light environment and population density on growth performance of male turkeys. Poult Sci. 1984;63(7):1314-1321.

Glatz P., Rodda B. Turkey farming: Welfare and husbandry issues. African Journal of Agricultural Research 2013;8(48):6149-6163.

Glebocka K. Gut health is a critical factor for litter quality. World Poult. 2008;24(12):12–13.

Grasenack H. Untersuchungen zur Entwicklung neuer Verfahren für die Mast von Broilerputen und schweren Puten [Dissertation med. vet.]. Leipzig: Universität Leipzig; 1976.

Graue J, Glawatz H, Meyer H. Area coverage of B.U.T. 6 commercial males determined by planimetric analyses. Abstracts of the 7th Hafez International Symposium on Turkey Production meeting of the Working Group 10 (Turkey) of WPSA, Berlin: Mensch-und-Buch-Verlag. 2013:66–68.

Grigor PN, Hughes BO, Gentle MJ. An experimental investigation of the costs and benefits of beak trimming in turkeys. The Veterinary Record. 1995;136(11):257.

Grimes JL, Smith J, Williams CM. Some alternative litter materials used for growing broilers and turkeys. World Poult Sci J. 2002;58(4):515-526.

Große Liesner B. Vergleichende Untersuchungen zur Mast- und Schlachtleistung sowie zum Auftreten (Häufigkeit/Intensität) primär nicht-infektiöser Gesundheitsstörungen bei Puten fünf verschiedener Linien. [Dissertation med. vet.]. Hannover: Tierärztliche Hochschule Hannover. 2007.

Günther R. Wie Licht Verhalten, Wachstum und Gesundheit beeinflusst. DGS Magazin. 2001;(35):39-41.

H

ten Haaf H. Putenmast: Produktionstechnische Tips. DGS Magazin. 1997;23,35-37.

Haase S. Physiologische und pathologische Befunde an den Hinterextremitäten bei genetisch verschiedenen Putenlinien und unterschiedlicher Rationsgestaltung, unter besonderer Berücksichtigung der tibialen Dyschondroplasie und der Pododermatitis [Dissertation med. vet]. Berlin: Freie Universität Berlin. 2006.

Habig C, Spindler B, Hartung J. Gegenwärtige Management- und Haltungsbedingungen bei nicht schnabelgekürzten Puten in der ökologischen Haltung: Abschlussbericht. Celle: Friedrich-Loeffler-Institut, Institut für Tierschutz und Tierhaltung. 2013.

Habig C, Spindler B, Beyerbach M, Kemper N. Evaluation of foot pad health and live weights in two lines of turkey hens kept under organic husbandry conditions in Germany. Berliner und Münchener Tierärztliche Wochenschrift. 2017;130(5/6):250–257.

Hafez, HM. Übersicht über Probleme der haltungs- und zuchtbedingten Erkrankungen bei Mastputen. Arch. Geflügelk. 1996;60:249-256.

Hafez HM, Jodas S. Putenkrankheiten. Vetspecial, Enke.1997.

Hafez HM. Gesundheitsstörungen bei Puten im Hinblick auf die tierschutzrelevanten und wirtschaftlichen Gesichtspunkte. Arch. Geflügelk. 1999:63.

Hafez H M, Wäse K, Haase S, Hoffmann T, Simon O, Bergmann V. Leg disorders in various lines of commercial turkeys with especial attention to pododermatitis. Proceedings of the 5th International Symposium on Turkey Diseases Berlin. Gießen: DVG-Service-GmbH. 2004:11–18.

Hafez HM, Rudolph M, Haase S, Hauck R, Behr K-P, Bergmann V, Günther R. Influence of stocking density and litter material on the incidence of Pododermatitis of turkeys. Proceedings of the 3rd International Meeting of the Working Group 10 (Turkey) of WPSA. Berlin: Mensch-und-Buch-Verlag. 2005:101-109.

Hafez HM. The breeding and hatchery is an integrated part of turkey health. Proceedings of the 4th International Symposium on Turkey Production, meeting of the Working Group 10 (Turkey); Berlin: Mensch-und-Buch-Verlag. 2007:207–219.

Hafez HM, Hagen N, Allam TS. Influence of stocking density on health condition in meat turkey flocks under field conditions. Pak. Vet. J. 2016;36:134-139.

Hale EB, Schleidt WM, Schein MW. The behaviour of turkeys. In: E.S.E. Hafez (Ed.): The behaviour of domestic animals. London: Bailliere, Tindall & Cassel. 1969:554–592.

Hart N, Partridge C, Cuthill I. Visual pigments, cone oil droplets, ocular media and predicted spectral sensitivity in the domestic turkey (Meleagris gallopavo). Vis. Res. 1999; 39:3321–3328.

Hartung J. Staubbelastung in der Nutztierhaltung. Zbl. Arbeitsmed. 1997;47:65–72.

Healy W. Behaviour. In: Dickson JG, Hrsg. The Wild Turkey – Biology and Management. Mechaniesburg: Stackpole Books. 1992:46–65

Heidemark (o. J.): Wissenswertes zur Putenhaltung. Heidemark Mästerkreis GmbH & Co. KG. URL: https://www.heidemark.de/landwirtschaft/haltungsbedingungen/ (downloaded on 29.10.2020).

Hester PY, Peng IC, Adams RL, Furumoto EJ, Larsen JE, Klingensmith PM, Pike OA, Stadelman WJ. Comparison of two lighting regimens and drinker cleaning programmes on the performance and incidence of leg abnormalities in turkey males. British poultry science. 1986;27(1):63-73.

Hester P, Sutton A, Elkin R. Effect of light intensity, litter source and litter management on the incidence of leg abnormalities and performance of male turkeys. Poult Sci. 1987;66:666-675.

Hester P, Kohl H. Effect of intermittent lighting and time of hatch on large broad-breasted white turkeys. Poult Sci. 1988;68:1-4

Hester PY, Cassens DL, Bryan TA. The applicability of particleboard residue as a litter material for male turkeys. Poult Sci. 1997;76(2):248–55.

Hendrix Genetics. Hendrix Genetics' Turkey Brands. URL: https://www.hendrix-genetics.com/en/animalbreeding/turkey-breeding (downloaded on 29.10.2020).

Hiller P, Schierhold S, Meyer A. (2013) : Abschlussbericht „Tierwohl und Nachhaltigkeit in der Putenhahnenmast“, gemeinsamer Versuch der Landwirtschaftskammern Niedersachsen und Nordrhein-Westfalen mit Unterstützung des Vereins zur Putenforschung Kartzfehn, https://www.ml.niedersachsen.de/download/91515/Abschlussbericht_Tierwohl_und_Nachhaltigkeit_in_der_Putenhahnenmast.pdf. downloaded on 24.9.2020

Hirt H. Zuchtbedingte Haltungsprobleme am Beispiel der Mastputen. Tierärztliche Umschau. 1998;53(3):137–140.

Hockenhull Turkeys. Products & Prices. Hockenhull Turkeys Ltd. URL: http://www.hockenhullturkeys.co.uk/productsandprices.php?LMCL=awVaOQ (downloaded on 29.10.2020).

Hocking PM. Welfare of food restricted male and female turkeys. Br Poult Sci. J. 40. 1999a;40(1):19-29.

Hocking, PM. Assessment of pain during locomotion and the welfare of adult male turkeys with destructive cartilage loss of the hip joint. Br Poult Sci. J. 40. 1999b;40(1):30-34.

Hocking PM. Wu K. Traditional and commercial turkeys show similar susceptibility to foot pad dermatitis and behavioural evidence of pain. Br Poult Sci. 2013;54(3):281–288.

Hocking PM. Unexpected consequences of genetic selection in broilers and turkeys: problems and solutions. Br Poult Sci. 2014;55(1):1–12.

Hörnig B. Mögliche Auswirkungen der Leistungszucht beim Geflügel auf das Tierwohl. Fortbildungsveranstaltung zum Fachgebiet Tierschutz und Tierschutzethik. Berlin: Landestierärztekammer FU Berlin. 2017.

Hoy S, Gauly M, Krieter J. Nutztierhaltung und –hygiene: Grundwissen Bachelor; 114 Tabellen. Stuttgart: Ulmer. 2006. ISBN 3-8252-2801-0.

Hübel J, Bergmann S, Ziegler N, Willig R, Truyen U, Erhard MH, Krautwald-Junghanns M-E. Vergleichende Feldstudie zur Einstreufeuchtigkeit und zur Fußballengesundheit während der Aufzucht von Mastputen. Berliner und Münchener Tierärztliche Wochenschrift. 2014;127(7/8):274–89.

Hübel J. Fußballenentzündung, Einstreufeuchtigkeit und Mortalität als Tierschutzindikatoren in der Aufzuchtphase von Mastputen unter Berücksichtigung von Besatzdichte und Körpermasse [Dissertation med. vet]. Leipzig: Universität Leipzig; 2019.

Huesmann K. Tiergerechte Mastputenhaltung mit Beschäftigungs-und Strukturelementen. Landtechnik 2008; 3:183-184

Huff GR, Huff WE, Rath NC, Balog JM. Turkey osteomyelitis complex. Poult Sci. 2000;79(7):1050-1056.

Hughes BO, Grigor PN. Behavioural time budgets and beak-related behaviour in floor housed turkey. Anim Welfare. 1996;5:189–198.

Hurst GA. Foods and Feeding. The Wild Turkey Biology and Management. Mechaniesburg': Stackpole Books, Harrisburg, Pennsylvania, USA. 1992: 66–83

Hünigen H, Mainzer K, Hirschberg RM, Custodis P, Gemeinhardt O, Al Masri S, Richardson KC, Hafez HM, Plendl J: Structure and age-dependent development of the turkey liver: a comparative study of a highly selected meat-type and a wild-type turkey line. Poultry Science. 2016. 95 (4): 901–911

Hybrid. Zuchtverfahren in der Putenindustrie. Hendrix Genetics BV. 2015. URL: http://resources.hybridturkeys.com/system/resources (downloaded on 29.10.2020).

I/J

Jankowski, J., D. Mikulski, M. R. Tatara, and W. Krupski. 2015. Effects of increased stocking density and heat stress on growth, performance, carcass characteristics and skeletal properties in turkeys. Vet. Rec. 176:21–26.

Jensen L, Merril L, Keddy C, Mcginnis J. Observations of eating patterns and rate of food passage of birds fed pelleted and unpelleted diets. Poult. Sci. 1962; 41. 1414-1419

Jodas S, Hafez HM. Litter management and related diseases in turkeys. Proceedings of the 3rd International Symposium on Turkey Diseases, Berlin. Gießen: DVG-Verlag. 2000a:77–87.

De Jong IC, Swalander M. Housing and management of broiler breeders and turkey breeders. Alternative systems for poultry: health, welfare and productivity. Oxfordshire: Cabi. 2012:225-249.

K

Kapell DNRG, Hocking PM, Glover PK, Kremer VD, Avendaño S. Genetic basis of leg health and its relationship with body weight in purebred turkey lines. Poult Sci. 2017;96(6):1553-1562

Kämmerling D, Döhring S, Arndt C, Andersson R. Tageslicht im Stall–Anforderungen an das Spektrum von Lichtquellen bei Geflügel. Berliner und Münchner Tierärztliche Wochenschrift. 2017;130:210-221.

Kartzfehn. Informationen zur Putenmast. Bösel: Moorgut Kartzfehn. 2017.https://www.kartzfehn.de/beratung/downloads.html (downloaded on 3.11.2020).

Kamphues J, Youssef IM, Abd El-Wahab A, Sürie C. Lignocellulose Vorteil für die Fußballengesundheit? DGS. 2011a;(5):10–7.

Kamphues J, Youssef IM, Abd El-Wahab A, Üffing B, Witte M, Tost M. Einflüsse der Fütterung und Haltung auf die Fußballengesundheit bei Hühnern und Puten. Übersichten zur Tierernährung. 2011b;39:147–95.

Karcher DM, Mench JA. Overview of commercial poultry production systems and their main welfare challenges. In: Advances in Poultry Welfare. Cambridge: Woodhead Publishing. 2018:3-25.

Kelly Turkey Farms. Bred to be wild. URL: https://www.kellybronze.co.uk/ (downloaded on 29.10.2020)

Korbel R, Jacoby J., Kösters J. Light perception in turkeys – hypothesis on influences of behavior. Proceedings of the Turkey Symposium. Berlin. 1998:244-248.

Korbel R, Sturm K. Review on light sources for bird housing under artificial light circumstances under special consideration of turkey farming. Proceedings of the 3rd International Meeting, Turkey Symposium. Berlin. 2005:144-146 van der Klis JD, Veldkamp T. Wet litter in turkeys: prevention or damage control? Proceedings of the 5th International Symposium on Turkey Diseases, Berlin. Gießen: DVG; 2004:239–44.

Korthas G. Der Einfluss von Klima und Besatzdichte auf die Mastleistung schwerer Puten. In: Haendler H, Hrsg. Puten: Krankheiten, Fütterung und Haltung, Ausschlachtung und Verwertung: Seminar an der Universität Hohenheim 1981. Hohenheimer Arbeiten Reihe tierische Produktion 116. Stuttgart: Ulmer; 1982:85–97.

Krautwald-Junghanns, M-E. Putenproduktion in Deutschland: Ansätze für eine tierschutzgerechtere Haltung. Dtsch. Tierärztebl. 2003;1:4–8.

Krautwald-Junghanns ME, Fehlhaber K, Bartels T, Böhme J, Cramer K, Dellavolpe A, Ellerich R, Ludewig M, Mitterer-Istyagin H, Seelbach S: Abschlussbericht zum Forschungsauftrag Indikatoren einer tiergerechten Mastputenhaltung. BLE 2009a: 1-176.

Krautwald-Junghanns M-E, Ellerich R, Böhme J, Cramer K, DellaVolpe A, Mitterer-Istyagin H, Ludewig M, Fehlhaber K, Schuster E, Berk J, Aldehoff D, Fulhorst D, Kruse W, Dressel A, Noack U, Bartels T. Examination of rearing standards and health status in turkeys in Germany. Berliner und Münchner Tierärztliche Wochenschrift. 2009b;122(7/8):271–283.

Krautwald-Junghanns ME, Ellerich R, Mitterer-Istyagin H, Ludewig M, Fehlhaber K, Schuster E, Berk J, Dressel A, Petermann S, Kruse W, Noack U, Albrecht K, Bartels T. Untersuchungen zur Prävalenz von Hautverletzungen bei schnabelkupierten Mastputen. Berliner und Münchner Tierärztliche Wochenschrift. 2011a;124: 8–16.

Krautwald-Junghanns ME, Ellerich R, Mitterer-Istyagin H, Ludewig M, Fehlhaber K, Schuster E, Berk J, Petermann S, Bartels T. Examinations on the prevalence of foot pad lesions and breast skin lesions in British United Turkeys Big 6 fattening turkeys in Germany. Part I: Prevalence of foot pad lesions. Poult Sci. 2011b;90(3):555–60.

Krautwald-Junghanns ME, Erhard MH, Bartels T, Bergmann S, Ziegler N, Schweizer C, Brandl S. Abschlussbericht zum Forschungsauftrag Indikatoren einer tiergerechten Mastputenhaltung in der Aufzuchtphase. BLE. 2012: 1-156

Krautwald-Junghanns M-E, Bergmann S, Erhard MH, Fehlhaber K, Hübel J, Ludewig M, Mitterer-Istyagin H, Ziegler N, Bartels T. Impact of selected factors on the occurrence of contact dermatitis in turkeys on commercial farms in Germany. Animals. 2013;3(3):608–28.

Krautwald-Junghanns ME. Influence of different housing conditions on the prevalence of foot pad dermatitis in fattening turkeys. Proceedings of the 9th turkey science and production conference. Chester. 2015:7-8.

Krautwald-Junghanns ME, Bartels T, Berk J, Deerberg F, Dressel A, Erhard MH, Ermakow O, Freihold D, Hafez HM, Huchler M, Ludewig M, Mitterer-Istyagin H, Spindler B, Thieme S.: Abschlussbericht zum Forschungsauftrag Indikatoren einer tiergerechten Mastputenhaltung unter den Bedingungen der ökologischen Geflügelmast. BLE/ BÖLN. 2017.

Kristensen HH, Wathes CM. Ammonia and poultry welfare: a review. Worlds Poult. Sci. J. 2000;56:235–245.

Kristensen, HH. The effects of light intensity, gradual changes between light and dark and definition of darkness for the behaviour and welfare of broiler chickens, laying hens, pullets and turkeys. Scientific Report for the Norwegian Scientific Committee for Food Safety. 2008:1-44.

Kuenzel WJ. Neurobiological basis of sensory perception: welfare implications of beak trimming. Poultry Science. 2007; 86(6), pp.1273-1282.

Kulke, K., Habig, C., Kemper, N., Spindler, B. Untersuchungen zum Vorkommen von Kannibalismus bei nicht schnabelgekürzten Putenhähnen bei unterschiedlichen Besatzdichten. Abschlussbericht Projekt Tierschutzplan Niedersachsen. 2014.

Kulke, K, Spindler, B., Kemper, N. A waiver of beak-trimming in turkeys-current situation in Germany. 2016; Züchtungskunde 88.6: 456-474.

Kulke K, Spindler B, Beyerbach M, Freytag S, Habig C, Kemper N. Planimetrische Untersuchungen bei Putenhähnen der Linie B.U.T. 6 in der Aufzucht- und Mastperiode. Berliner und Münchner Tierärztliche Wochenschrift. 2017;130(5):266–72.

L

Landwirtschaftskammer Niedersachsen und NRW. Abschlussbericht Tierwohl und Nachhaltigkeit in der Putenhahnenmast, gemeinsamer Versuch der Landwirtschaftskammern Niedersachsen und Nordrhein-Westfalen mit Unterstützung des Vereins zur Putenforschung Kartzfehn. 2011.

Le Bris J. Gesundheit, Leistung und Verhalten konventioneller Mastputenhybriden unter den Bedingungen ökologischer Haltungsanforderungen [Dissertation med. vet]. München: Ludwig-Maximilians-Universität-München. 2005.

Leis ML, Dodd MMU, Starrak G, Vermette CJ, Gomis S, Bauer BS, Sandmeyer LS, Schwean-Lardner K, Classen HL, Grahn BH. Effect of prolonged photoperiod on ocular tissues of domestic turkeys. Veterinary ophthalmology. 2017;20(3):232-241.

Levenick CK, Leighton Jr AT. Effects of photoperiod and filtered light on growth, reproduction, and mating behavior of turkeys: 1. Growth performance of two lines of males and females. Poult Sci. 1988;67(11):1505-1513.

Letzguß H, Bessei W. Effects of environmental enrichment on the locomotor activity of turkeys. Poult Welfare Symp. Cervia. 2009:46.

Letzguß H. Einfluss von Beschäftigungs- und Strukturelementen auf das Verhalten und das Beinskelett konventionell gehaltener Mastputen. [Dissertation agr.]. Institut für Tierhaltung und Tierzüchtung. Hohenheim: Universität Hohenheim. 2010.

Lehr-, Versuchs- und Fachzentrum Kitzingen (LVFZ). Einfluss des Einstreusubstrates, der IR Schnabelbehandlung und Blunting auf die Leistung und Tiergesundheit von B.U.T. 6 Hähne. 2015. URL: http://www.lfl.bayern.de/lvfz/kitzingen/090597/index.php (downloaded on 29.10.2020).

Leighton AT, Mason JP. The effect of ventilation rate, sex and modified vs. conventional litter floors on performance of two varieties of turkeys. Poult Sci. 1973;52(4):1611–20.

Leighton AT, Hulet RM, Denbow DM. Effect of light sources and light intensity on growth performance and behavior of male turkeys. Br Poult Sci. 1989;30(3):563-574.

Levenick CK, Leighton Jr AT. Effects of photoperiod and filtered light on growth, reproduction, and mating behavior of turkeys. 1. Growth performance of two lines of males and females. Poult Sci. 1988;67(11):1505-1513.

Lewis JC. "Observations on the winter range of wild turkeys in Michigan." The Journal of Wildlife Management 1963: 98-102.

Lewis PD, Perry GC, Sherwin CM. Effect of intermittent light regimens on the performance of intact male turkeys. Anim. Sci. 1998a;67:627-638

Lewis, PD, Morris TR. Responses of domestic poultry to various light sources. World's Poult Sci. J. 1998b;54(1): 7-25.

Lewis PD, Perry GC, Sherwin CM, Moinard C. Effect of ultraviolet radiation on the performance of intact male turkeys. Poult. Sci. 2000a;79:850–855.

Lewis, PD, Morris TR. Poultry and coloured light. World's Poult. Sci. J. 2000b;56:189–207.

Löliger H. Technopathien beim Geflügel. In: Heider G, Monreal G. Hrsg. Krankheiten des Wirtschaftsgeflügels. Jena: Fischer Verlag. 1992:291-309.

M

Mailyan E, van Schie T, Heijmans M, Nixey C, Buddiger N, Günther R, Hafez HM, Holleman J. Putensignale – Praxisleitfaden für die Putenhaltung. Zutphen: Roodbont Agricultural Publishers. 2019: 198

Manser C. Effects of lighting on the welfare of domestic poultry: A review. Anim. Welfare. 1996;5:341-360.

Marchewka J, Watanabe T N, Ferrante V, Estevez I. Review of the social and environmental factors affecting the behaviour and welfare of turkeys (Meleagris gallopavo). Poult Sci 2013;92:1467-1473.

Marchewka J, Estevez I, Vezzoli G, Ferrante V, Makagon MM. The transect method: a novel approach to on-farm welfare assessment of commercial turkeys. Poult Sci. 2015;94(1):7–16.

Marchewka J, Guro V, Moe RO. Associations between on-farm welfare measures and slaughterhouse data in commercial flocks of turkey hens (Meleagris gallopavo). Poult Sci. 2020.

Marks, J. Untersuchung der Einflüsse von erhöhten Sitzgelegenheiten auf Tierwohl und Tiergesundheit unter Beachtung von wirtschaftlichen Parametern bei Putenelterntieren. [Dissertation med. vet.]. Hannover: Tierärztliche Hochschule Hannover. 2017.

Marks J. Einfluss einer NSAID-Behandlung auf wichtige Leistungsparameter schnabelbehandelter Putenküjken. Der Praktische Tierarzt. 2020;101(08):778-787

Martland MF. Wet litter as a cause of plantar pododermatitis, leading to foot ulceration and lameness in fattening turkeys. Avian Pathology. 1984;13(2): 241-252.

Martrenchar A. Animal welfare and intensive production of turkey broilers. Worlds Poult Sci J. 1999a;55(2):143–52.

Martrenchar A, Huonnic D, Cotte JP, Boilletot E, Morisse JP. Influence of stocking density on behavioural, health and productivity traits of turkeys in large flocks. Br Poult Sci. 1999b;40:323-331.

Martrenchar A, Huonnic D, Cotte JP. Influence of environmental enrichment on injurious pecking and perching behaviour in young turkeys. Br Poult Sci. 2001;42.161–170.

Martrenchar A, Boilletot E, Huonnic D, Pol F. Risk factors for food-pad dermatitis in chicken and turkey broilers in France. Preventive veterinary medicine 2002; 52: 213-226.

Maxwell MH, Hocking PM, Robertson GW. Differential leucocyte responses to various degrees of food restriction in broilers, turkeys and ducks. Br Poult Sci. 1992;33(1):177-187.

Mayne RK, Martrenchar A, Boilletot E, Huonnic D, Pol F. Risk factors for foot-pad dermatitis in chicken and turkey broilers in France. Prev Vet Med. 2002;52:213-26.

Mayne RK. A review of the aetiology and possible causative factors of foot pad dermatitis in growing turkeys and broilers. Worlds Poult. Sci. 2005;61:265–267.

Mayne RK, Hocking P, Else R. Foot pad dermatitis develops at an early age in commercial turkeys. Br Poultry Sci. 2006;47(1):36-42.

Mayne RK, Else RW, Hocking PM. High litter moisture alone is sufficient to cause foot pad dermatitis in growing turkeys. Br Poult Sci. 2007;48(5):538–45.

McCrea BA, Leslie MA, Stevenson LM, Macklin KS, Bauermeister LJ, Hess JB. Live performance characteristics, pathogen load and foot pad lesions in range-reared heritage vs. conventional turkeys (Meleagris gallopavo). Poult Sci. J. 2012;11(7):438.

Mendes AS, Jorge de Moura D, Bischoff Nunes I, Lopes Dos Santos I, de Souza C, Munhoz Morello G, Endo Takahashi S. Behavioral responses of turkeys subjected to different climatic conditions. Tropical Animal Health and Production 2020:1-8.

Menges J. Environmental management of commercial turkeys. Proceedings of the 6th International Symposium on Turkey Production, meeting of the Working Group 10 (Turkey). Berlin: Mensch-und-Buch-Verlag. 2011. S. 243–249.

Meyer H, Graue J, Glawatz H. Entertainment and barn enrichment for commercial turkeys. Proceedings of the 7th International Symposium on Turkey Production. Berlin: Mensch-und-Buch-Verlag. 2013:72–79.

Millam JR. Preference of turkey hens for nest-boxes of different levels of interior illumination. Appl. Anim. Beh. Sci.. 1987;18(3-4):341-348.

Mirza MW. Improvement in litter quality and leg health by nutritional modification in growing turkeys [PhD thesis]. Glasgow: University of Glasgow. 2011.

Mitterer-Istyagin H, Ludewig M, Bartels T, Krautwald-Junghanns M-E, Ellerich R, Schuster E, Berk J, Petermann S, Fehlhaber K. Examinations on the prevalence of foot pad lesions and breast skin lesions in B.U.T. Big 6 fattening turkeys in Germany. Part II: Prevalence of breast skin lesions (breast buttons and breast blisters). Poult Sci. 2011;90(4):775–80.

Moinard C, Sherwin CM. Turkeys prefer fluorescent light with supplementary ultraviolet radiation. Appl. Anim. Beh. Sci., 1999;64:261-267

Moinard C, Lewis PD, Perry GC, C. M. Sherwin CM. The effects of light intensity and light source on injuries due to pecking of male domestic turkeys (Meleagris gallopavo). Animal Welfare. 2001;10:131-139

Monckton V, van Staaveren N, Baes C, Balzani A, Know I, McBride P, Harlander-Matauschek A. Are turkeys (Meleagris gallopavo) motivated to avoid excreta-soile substrate? Animals 2020; 10. Doi:10.3390/ani10112015

N

Nagaraj KV, Emery DA, Jordan KA, Newmann JA, Pomeroy BS. Scanning electron microscopic studies of adverse effects of ammonia on tracheal tissues of turkeys. Am. J. Vet. Res. 1983;44(8):1530–1636.

Nagaraj M, Wilson CA, Saenmahayak B, Hess JB, Bilgili SF. Efficacy of a litter amendment to reduce pododermatitis in broiler chickens. Journal of Applied Poultry Research. 2007;16(2):255-61.

National Turkey Federation (NTF). Animal care best management practices production guidelines. 2012:1–53. URL: www.eatturkey.com/sites/default/files/welfarm²012.pdf (downloaded on 29.10.2020).

National Farm Animal Care Council. Code of Practice for the Care and Handling of Hatching Eggs, Breeders, Chicken and Turkeys. 2016:82.

Naturland. Naturland Richtlinien. Naturland e.V. URL: https://www.naturland.de/images/Naturland/Richtlinien/Naturland-Richtlinien_Erzeugung.pdf 2018. (downloaded on 29.10.2020)

Neuland. Richtlinien für die artgerechte Putenhaltung. URL: https://www.neuland-fleisch.de/wp-content/uploads/2019/09/19_08_23_Richtlinien-Mastputen.pdf (downloaded on 18.11.2020)

Newberry RC. The role of temperature and litter type in the development of breast buttons in turkeys. Poult Sci. 1993;72(3):467–74.

Nguyen LP, Josef Hamr J, Parker GH. Nest site characteristics of eastern wild turkeys in central Ontario. Northeastern Naturalist. 2004;11(3):255-260.

NMELV, Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz Niedersachsen, Tierschutzdienst des Niedersächsischen Landesamtes für

Verbraucherschutz und Lebensmittelsicherheit, Landesverband der Niedersächsischen Geflügelwirtschaft. Managementempfehlungen zur Erhaltung der Fußballengesundheit bei Mastputen. 2013:14–18.

NMELV, Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz Niedersachsen. Empfehlungen zur Vermeidung des Auftretens von Federpicken und Kannibalismus bei Puten sowie Notfallmaßnahmen beim Auftreten von Federpicken und Kannibalismus. Celle: Ströher Druckerei. 2019a.

NMELV, Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz Niedersachsen, Tierschutzdienst des Niedersächsischen Landesamtes für Verbraucherschutz und Lebensmittelsicherheit, Landesverband der Niedersächsischen Geflügelwirtschaft. Merkblatt zur Vermeidung von Hitzestress bei Puten. 2019b.

NMELV, Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz Niedersachsen. Mindestanforderungen an die Haltung von Puten in der Fassung der Bekanntmachung vom 10. Juli 2019. Niedersächsisches Ministerialblatt (Nds. MBl.). 2019c;27:1026.

Nicholas. Management essentials: for Breeder Turkeys. An Aviagen Group Company: 2003. www.nicholas-turkey.com (downloaded on 18.11.2020).

Noble D., Nestor, K, Polley C. Range and confinement rearing of four genetic lines of turkeys. 1. Effects on growth, mortality and walking ability. Poult Sci. 1996;75(2):160–164

Noll SL, Halawani M, Waibel P, Redig P, Janni K. Effect of diet and population density on male turkeys under various environmental conditions: 1. Turkey growth and health performance. Poult. Sci. 1991;70:923–934.

Noll SL, Janni K A, Halvorson D A, Clanton C J. Market turkey performance, air quality, and energy consumption affected by partial slotted flooring. Poult Sci. 1997;76:271-279.

Norwegian Ministry of Agriculture and Food. Regulation on keeping broilers and turkeys §36 d) 2001. https://lovdata.no/dokument/SF/forskrift/2001-12-12-1494#KAPITTEL_9 (downloaded on 29.10.2020)

O

Olschewsky A. Untersuchung der Eignung alternativer Putenherkünfte für ein ökologisches Haltungssystem. [Diss.agr.]. Kassel: Universität Kassel. 2019.

Österreichische Qualitätsgeflügelvereinigung (QGV). Programm des Geflügelgesundheitsdienstes QGV zur Optimierung der Haltungsbedingungen und der Produktqualität von Masthühnern (Gallus gallus) und Truthühnern (Meleagris gallopavo). 2008:1–13.

P

Parvin R, Mushtaq MMH, KIM MJ, Choi HC. Light emitting diode (led) as a source of monochromatic light: A novel lighting approach for immunity and meat quality of poultry. Worlds Poult Sci. J. 2014;70:557-562.

Perkins S, Zuidhof M, Feddes J, Robinson F. Effect of stocking density on air quality and health and performance of heavy tom turkeys. Can. Agr. Eng. 1995; 37: 109-112

Petermann S, Fiedler H. Eingriffe am Schnabel von Wirtschaftsgeflügel – eine tierschutzrechtliche Beurteilung. Tierärztliche Umschau 1999; 54: 8-19

Prescott NB, Wathes CM. Spectral sensitivity of the domestic fowl (Gallus f. dom.). Brit. Poult. Sci. 1999;40:332-339.

Prusik M, Lewczuk B. Diurnal Rhythm of Plasma Melatonin Concentration in the Domestic Turkey and Its Regulation by Light and Endogenous Oscillators. Animals. 2020;10(4):678.

Q

Quinton CD, Wood BJ, Miller SP. Genetic analysis of survival and fitness in turkeys with multiple trait animal models. Poult Sci. 2011;90(11):2479–86.

R

Radko D, Gooß O, El-Wahab A, Sürie C, Kamphues J. Tiergesundheit: Gesunde Füße mit Strohgranulat. DGS. 2012;(5):22–6.

Rajchard J. Ultraviolet (UV) light perception by birds: A review. Vet. Med. 2009;54:351–359.

Reece FN, Bates BJ, Lott BD. Ammonia control in broiler houses. Poult. Sci. 1979;58:754–755.

Reiter K, Bessei W. Einfluss der Laufaktivität auf die Beinschäden beim Mastgeflügel. Berliner und Münchner Tierärztliche Wochenschrift. 2009;122:264-70.

Reiter, K. Verhalten von Puten. Hoy S. Hrsg. Nutztierethologie. Stuttgart: Ulmer. 2009:224–231

Richter T. Stallklima. In: Richter, T. Hrsg. Krankheitsursache Haltung: Beurteilung von Nutztierställen- ein tierärztlicher Leitfaden. Stuttgart: Enke Verlag in MVS. Medizinverlage Stuttgart GmbH & Co.KG, 2006:20–27.

Ringgenberg N, Stratmann A. Die Benutzung von erhöhten Sitzgelegenheiten von Mastputen. 50.Internationale Tagung Angewandte Ethologie, Freiburg. 2018

Rodenburg TB, Turner SP. The role of breeding and genetics in the welfare of farm animals. Anim Front. 2012;2:16–21.

Rudolf M. Einfluss von Besatzdichte und Einstreumaterial auf die Pododermatitis bei Mastputen [Dissertation med. vet]. Berlin: Freie Universität Berlin. 2008.

Russell SM, Grimes JL, Gernat AG. Nipple drinkers for brooding commercial large white turkeys. Poult Sci. J. 2009;8(6):521–8.

RSPCA, Royal Society for the Prevention of Cruelty to Animals. RSPCA welfare standards for turkeys. 2017. ISBN 1898331 80 4.

S

Sahan U, Ipek A, Yilmaz Dikmen B. The welfare of egg layer, broiler and turkey. In EPC 2006-12th European Poult Conference. Verona. World's Poult Sci. Association. 2006.

Saunders J, Jarvis J, Wathes C. Calculating luminous flux and lighting levels for domesticated mammals and birds. Animal. 2008;6:921–932

Schlup P, Bircher L, Stauffacher M. Auswirkungen von Zucht und Haltung auf die Entwicklung des Fortbewegungsverhaltens von Hochleistungsputen (Meleagris gallopavo ssp.). Aktuelle Arbeiten zur artgemäßen Tierhaltung, KTBL-schrift. 1990;344:47-59

Schulze-Bisping M.: Auswirkungen eines Verzichts auf das Schnabelkürzen sowie von tierischem Eiweiß im Mischfutter auf Federpicken und Kannibalismus bei Mastputenhennen. vet.med. Dissertation, TiHo Hannover, Dr. Hut Verlag. 2015

Schumacher C, Krautwald-Junghanns M-E, Hübel J, Bergmann S, Mädl N, Erhard MH, Berk J, Pees M, Truyen U, Bartels T. Einfluss der Einstreufeuchte im Futter- und Tränkebereich auf die Fußballengesundheit von Mastputen in der Aufzuchtphase. Berliner und Münchner Tierärztliche Wochenschrift. 2012;125(9/10):379–85.

Schumacher C. Untersuchungen zur Bedeutung von Futter- und Tränkebereichen für die Fußballengesundheit von Mastputen sowie Untersuchungen zu weiteren Einflussfaktoren im Aufzuchtalter. 2014. [Dissertation med. vet] Leipzig, Universität Leipzig

Schwean-Lardner K, Vermette C, Leis M, Classen HL. Basing turkey lighting programs on broiler research: a good idea? A comparison of 18 daylength effects on broiler and turkey welfare. Animals. 2016;6(5):27.

Schweizer CH. Gesundheit, Leistung und Fleischqualität von gemischt gehaltenen B.U.T Big 6 und Kelly Bronze Puten in der Auslaufhaltung. [Dissertation med. vet.]. München: Ludwig-Maximilians-Universität. 2009.

Sherwin CM. Light intensity preferences of domestic male turkeys. Appl Anim Behav Sci. 1998a;58:121–130.

Sherwin CM, Kelland A. Time budgets, comfort behaviours and injurious pecking of turkeys housed in pairs. Br Poult Sci 1998b;39:325-332

Sherwin, CM, Lewis PD, Perry GC. Effects of environmental enrichment, fluorescent and intermittent lighting on injurious pecking amongst male turkey poults. Br. Poult. Sci. 1999a;40:592-598

Sherwin, CM, Devereux CL. Preliminary investigations of ultraviolet induced markings on domestic turkey chicks and a possible role in injurious pecking. Br. Poult. Sci. 1999b;40:429–433.

Sherwin, CM, P. D. Lewis PD, Perry GC. The effects of environmental enrichment and intermittent lighting on the behaviour and welfare of male domestic turkeys. Appl. Anim. Behav. Sci. 1999c;62(4),319–333

Sherwin CM. Domestic turkeys are not averse to compact fluorescent lighting. Appl. Anim. Behav. Sci. 1999d;64:47–55.

Shoffner RN, Polley CR, Burger RE, Johnson EL. Light Regulation in Turkey Management: 1. Effect on Body Weight (Growth). Poult Sci. 1962;41(5):1560-1562.

Siopes TD, Timmons MB, Baughman GR, Parkhurst CR. The effects of light intensity on turkey poult performance, eye morphology, and adrenal weight. Poult Sci. 1984;63(5):904-909.

Siopes TD, Baughman GR, Parkhurst CR, Timmons MB. Relationship between duration and intensity of environmental light on the growth performance of male turkeys. Poult Sci. 1989;68(11):1428-1435.

Siopes TD. Initiation of egg production by turkey breeder hens: Sexual maturation and age at lighting. Poult Sci. 2010;89(7):1490-1496.

Smith-Blair AE. Rio Grande wild turkey hen habitat and edge use, survival, and reproductive characteristics in the Texas Rolling Plains. [Msc. thesis]. 1993.

Spindler B. Pathologisch-anatomische und histologische Untersuchungen an Gelenken und Fußballen bei Puten der Linie B.U.T. Big 6 bei der Haltung mit und ohne Außenklimabereich [Dissertation med. vet]. Hannover: Tierärztliche Hochschule Hannover. 2007.

Spindler B, Hartung J. Abschlussbericht: Modellvorhaben “Landwirtschaftliches Bauen 2005-2007“ Tiergerechte Mastputenhaltung mit Beschäftigungs- und Strukturelementen.Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL). 2007.

Spindler B., Hartung, J. Influence of environmental enrichment on the behaviour of female Big 6 turkeys reared on an ecological farm. Proceedings XIV ISAH Congress, Vechta. 2009; 1: 359-362.

Spindler B, Schulze Hillert M, Sürie C, Kamphues J, Hartung J. Untersuchungen zum Verzicht auf Schnabelkürzen bei Mastputenhennen – Kann der Einsatz von tierischem Eiweiß im Alleinfutter Federpicken und Kannibalismus bei Putenhennen reduzieren? Abschlussbericht. Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz. 2012.

Spindler B, Hartung J, Habig C, Berk J. Abschlussbericht: Gegenwärtige Management- und Haltungsbedingungen bei nicht schnabelgekürzten Puten in der ökologischen Haltung. 2013a.

Spindler B, Hartung J, Habig C, Berk J. Gegenwärtige Management- und Haltungsbedingungen bei nicht schnabelgekürzten Puten in der ökologischen Haltung. Stiftung Tierärztliche Hochschule Hannover, Institut für Tierhygiene, Tierschutz und Nutztierethologie. 2013b.

Spindler B, Giersberg MF, Briese A, Kemper N, Hartung J. Spatial requirements of poultry assessed by using a colour-contrast method (KobaPlan). Br Poult Sci. 2016;57(1):23–33.

Strassmeier P. Einfluss von Strukturelementen, Futterzusammensetzung und Witterung auf das Verhalten von gemischt gehaltenen BIG SIX und Kelly Bronze Puten in der Auslaufhaltung [Dissertation med. vet.]. München: Ludwig-Maximilians-Universität München. 2007.-

Stern A. Geflügel halten. Stuttgart: Kosmos Verlag. 1986:92-98

Strüve H, Recke G. Erfassung tierwohlspezifischer Parameter in der Putenhaltung zur Optimierung des betrieblichen Controllings. Informatik in der Land-, Forst-und Ernährungswirtschaft 2016a.

Strüve H, Strothotte A, Recke G. Abschlussbericht Betriebswirtschaftliche Analysen von Maßnahmen zur Verbesserung des Tierwohls bei putenhaltenden Betrieben. Osnabrück: Hochschule Osnabrück. 2016b.

Swalander M. Balanced breeding for Health and welfare traits. Proceedings of the 6th International Symposium on turkey production. Meeting of the Working Group 10 (Turkey) of WPSA. Berlin: Mensch-und-Buch-Verlag. 2011:30-37.

Swalander M. Balanced Breeding of Turkey for Health & Welfare Traits. Lohmann Information. 2012;47(1):43–8.

Swalander LM, Glover PK, Kremer VD, Bailey RA (2013) Driving robustness and gut health for the European Turkey Industry. In: Proc. of the 7th Turkey Science and Production Conference, Chester (UK). 2013: 34-37.

T

Taskin A, Karadavut U, Çayan H. Behavioural responses of white and bronze turkeys (Meleagris gallopavo) to tonic immobility, gait score and open field tests in free-range system, Journal of Applied Animal Research 2018; 46:1, 1253-1259

Teeter RG, Belay T, Cason JJ. Optimizing turkey and broiler production during heat stress. Poult Digest. 1996:21–29.

Toppel K, Kaufmann F, Schön H, Gauly M, Andersson R. Development of mortality and foot pad health in turkey flocks and its implication for welfare assessment. Berliner und Münchner Tierärztliche Wochenschrift. 2017a;130(5/6):258–265.

Toppel K, Strüve H, Recke G, Kaufmann F, Andersson R. Influence of "Legal Frameworks" on turkey husbandry in North-West Germany. Proceedings of the 11th Hafez International Symposium on Turkey Diseases. Berlin: Mensch-und-Buch-Verlag. 2017b:27–36.

Tschanz B. Ethologie und Tierschutz. In: Intensivhaltung von Nutztieren aus ethischer, ethologischer und rechtlicher Sicht. Tierhaltung / Animal Management. Basel: Verlag Birkhäuser 1985; 15.

Tzschentke B, Nichelmann M. Influence of age and wind speed on total effective ambient temperature in three poultry species (gallus domesticus, cairina moschata, meleagris gallopavo). Arch Geflügelk. 2000;64(1):1–8.

Tüller R. Faustzahlen zur Geflügelmast. In: Jahrbuch für die Geflügelwirtschaft. Stuttgart: Ulmer. 1997.

U

Uchtmann T. Außenklimabereich-positiv für die Gesundheit der Puten. DGS Magazin, 2004;32:24

V

Vehse K. Lichtwahrnehmung und –verarbeitung sowie Einfluss auf Wachstum, sexuelle Reifung, Verhalten und Gesundheit bei der Pute –eine bewertende Literaturübersicht. [Dissertation med. vet.]. Hannover: Tierärztliche Hochschule. 1998.

Vehse K, Ellendorff F. Influence of light on the physiology of turkeys: 1. growth. Arch. Geflügelkunde. 1999;63(2):59-72.

Vehse K, Ellendorff F. Influence of light on the physiology of turkeys: 2. sexual maturity. Arch. Geflügelkunde. 2000;65(1):1-12.

Veldkamp T. Growing turkeys on a ventilated litter floor. Proceedings of the 20th World's Poultry Congress. Bd. III. Neu-Delhi: World's Poult Sci. Association. 1996;3:659–663.

Veltmann JR, Gardner FA, Linton SS. Comparison of rice hull products as litter material and dietary fat levels on turkey poult performance. Poult Sci. 1984;63(12):2345–51.

Vermette C, Schwean-Lardner K, Gomis S, Grahn BH, Crowe TG, Classen HL. The impact of graded levels of day length on turkey health and behaviour to 18 weeks of age. Poult. Sci. 2016;95:1223–1237.

VKM. Risk assessment on welfare VKM. Risk assessment on welfare in turkeys. Opinion of the Panel of Animal Health and Welfare of the Norwegian Scientific Committee for Food Safety, ISBN: 978-82-8259-192-8, Oslo, Norway. 2016: 1-74

W

Wageningen UR Livestock Research. Animal welfare risk assessment guidelines on housing and management (EFSA Housing Risk). EFSA Supporting Publications. 2010,7(11): 87E.

Wang G, Ekstrand C, Svedberg J. Wet litter and perches as risk factors for the development of foot pad dermatitis in floor-housed hens. Br Poult Sci. 1998;39(2):191-197.

Wartemann S. Tierverhalten und Stallluftqualität in einem Putenmaststall mit Außenklimabereich unter Berücksichtigung von Tiergesundheit, Leistungsmerkmalen und Wirtschaftlichkeit. [Dissertation med. vet.]. Tierärztliche Hochschule Hannover: Tierärztliche Hochschule Hannover. 2005.

Wathes C. (zitiert nach Berk, 2002). Air and surface hygiene. In: Wathes C, Charles D. Livestock housing. Wallingford: CAB international 1994: 123-148.

Wathes C, Phillips V, Holden E. et al. (zitiert nach Berk, 2000). Emissions of aerial pollutants in live-stock buildings in Northern Europe. J. agric. Eng. Res. 1998; 70: 3-9

Watts CR, Stokes AW. The social order of turkeys. Scientific American. 1971;224(6):112-119.

Weber Wyneken C, Sinclair A, Veldkamp T, Vinco LJ, Hocking PM. Foot pad dermatitis and pain assessment in turkey poults using analgesia and objective gait analysis. Br Poult Sci. 2015:1–9.

Webster AB. Animal care guidelines and future directions. Poult Sci. 2007;86(6):1253–9.

Weidensaul C, Colvin B, Brinker D, Huy J. Use of ultraviolet light as an aid in age classification of owls. The Wilson Journal of Ornithology. 2011;123(2):373-377.

Welfarm. Dindes: La position de Welfarm conc. lélevage des dindes. Welfarm, protection mondiale des animaux de ferme. Metz 2016. URL: https://welfarm.fr/dindes (downloaded on 29.10.2020)

Werner SJ, Buchholz R, Tupper SK, Pettit SE, Ellis JW. Functional significance of ultraviolet feeding cues in wild turkeys. Physiol Behav. 2014;123:162-167.

Wesseling B, Glawatz H. Einstreu im Putenstall: Gesündere Füße durch Vilo Comfort. DGS. 2010;1:15–17.

Windhorst, H. (2009): The dynamics of turkey meat production and trade. Proceedings of the 5th International Symposium on Turkey production. Berlin: Mensch-und-Buch-Verlag. 2009:152–168

Wu K, Hocking PM. Turkeys are equally susceptible to foot pad dermatitis from 1 to 10 weeks of age and foot pad scores were minimized when litter moisture was less than 30%. Poult Sci. 2011;90(6):1170–8.

Wylie LM, Robertson GW, Macleod MG, Hocking PM. Effects of ambient temperature and restricted feeding on the growth of feathers in growing turkeys. Br Poult Sci. 2001;42(4):449-455.

Y

Yahav S, Hurwitz S, Rozenboim I. The effect of light intensity on growth and development of turkey toms. Br Poult Sci. 2000;41(1):101-106.

Yahav S, Rusal M, Shinder D. The effect of ventilation on performance body and surface temperature of young turkeys. Poult. Sci. 2008; 87(1):133-137.

Youssef IM, Beineke A, Rohn K, Kamphues J. Experimental study on effects of litter material and its quality on foot pad dermatitis in growing turkeys. International Journal of Poultry Science. 2010;9(12):1125–35.

Youssef IM, Beineke A, Rohn K, Kamphues J. Effects of litter quality (moisture, ammonia, uric acid) on development and severity of foot pad dermatitis in growing turkeys. Avian Dis. 2011;55(1):51–8.

Youssef IMI. Experimental studies on effects of diet composition and litter quality on development and severity of foot pad dermatitis in growing turkeys [Dissertation med. vet]. Hannover: Tierärztliche Hochschule Hannover. 2011.

Z

Zampiga M, Soglia F, Baldi G, Petracci M, Strasburg GM, Sirri F. Muscle Abnormalities and Meat Quality Consequences in Modern Turkey Hybrids. Frontiers in Physiology 2020(11): 554.

Ziegler N. Auswirkungen des Stallklimas auf die Fußballengesundheit von British United Turkeys 6 Mastputen während der Aufzuchtphase [Dissertation med. vet]. München: Ludwig-Maximilians-Universität-München. 2013.

Ziegler N, Bergmann S, Hübel J, Bartels T, Schumacher C, Bender A, Casalicchio G, Kuchenhoff H, Krautwald-Junghanns M-E, Erhard MH. Climate parameters and the influence on the foot pad health status of fattening turkeys B.U.T 6 during the early rearing phase. Berliner und Münchner Tierärztliche Wochenschrift. 2013;126(5/6):181–8.

Annexes

Annex 1a: General data on turkey parent stock husbandry

General data were available only to a very limited extent from the farms themselves and from books.

Turkeys are kept in intensive conditions on deep litter. Both sexes are housed together and separated by sex only as of 18 to 20 weeks of age (Hafez et al., 1997). The parent stock in breeding facilities is kept for about 54 weeks. Sexual maturity is reached when turkeys are between 28 and 30 weeks old (Aviagen Turkeys, 2017). Hens lay ca. 100 eggs during the following laying cycle of ca. 24 weeks (VKM, 2016).

Rearing phase

Turkey parents in the rearing phase are kept in forced-ventilated barns in floor housing with artificial light sources. Wood shavings or, less frequently, chopped straw or straw pellets are used as litter material. A rule of thumb for turkey poults to be housed is that the proportion of toms should be about 10% of the hens housed (de Jong et al., 2012).

During the rearing phase, it is also very important to regularly select those birds that are not suitable for further hatching egg production. These are mainly animals with poor growth, skeletal deformities or pendulous goiter. Additional selection steps can be taken as of the 16^{th} week of life for turkey parent stock by identifying the best developed animals and using only these for hatching egg production (Aviagen Turkeys, 2017; Hybrid, 2015).

A precisely controlled light programme is used to synchronise the start of egg laying or semen production. The lighting duration is ca. 14 hours up to the 14^{th} and 17^{th} week of life for toms and hens respectively. It is then gradually reduced to 6 to 8 hours for hens and 8 hours for toms. A subsequent increase of the lighting duration to 14 hours sets the stimulus for the start of egg laying or semen production. Hens need 14-21 days under increased light stimulus until the onset of laying, whereas toms need up to 6 weeks until the onset of semen production (Hybrid, 2015). For this reason, the lighting duration of toms is increased as early as 4 to 6 weeks prior to transfer to the laying farm, while the lighting duration for hens is usually increased when they are transferred to the laying farm at an age of 27 to 30 weeks.

Laying phase

During the laying phase, turkeys are kept exclusively in floor housing on litter such as wood shavings, straw or straw pellets in open barns or in forced-ventilation barns. Toms and hens are kept spatially separated as in the rearing phase. Single – or, more rarely, two-aisle semi-automatic nests are installed on both side walls or in a central corridor of the hen compartments so that one hen can visit the nest. No more than 5.5 to 6.5 hens should have to share one nest space (de Jong et al., 2012). The toms, on the other hand, are housed in small groups of 20 to 25 birds in what is known as paddocks (Nicholas, 2003). According to Hafez and Jodas, this was done in 1997 in a closed dark house with forced ventilation as of the 18^{th} week.

The hens are fed ad libitum with a feed specially adapted to their needs as laying birds. In order to prevent excessive daily weight gain of the toms and an associated deterioration in health and semen quality, a quantitative, and less frequently a qualitative, feed restriction is practised here even after transfer to the laying farm.

Artificial insemination of turkey hens has become established as a standard procedure for the commercial production of turkey eggs in recent decades (see below).

Sick pens

All breeding barns for turkeys are equipped with several small pens in which hens can be kept without nest boxes to prevent brooding. They are also used to house sick and injured birds. The aim here is to provide a refuge for the birds and to facilitate inspection by the keeper (VKM, 2016).

Stocking density

Hafez and Jodas describe stocking densities in 1997 of 1.8 birds/m² at 29-56 weeks of age. The 1995 FAWC guidelines recommend stocking densities during rearing of 36-38 kg/m² maximum at the end of rearing (at ca. 28-30 weeks of age) for closed forced-ventilated barns and 25 kg/m² for open naturally ventilated barns. This corresponds to a maximum of 3.0 to 3.5 hens/m², depending on the breed. Current recommendations in the UK limit stocking density to 19.4 kg/m² for hens and to no more than 1 tom/m² (Table 1; FAWC, 1995).

Stocking density for turkey parent stock (FAWC, downloaded on 17.09.2020)

Housing type	**Stocking density**
In the barn	515 cm²/kg
Toms for artificial insemination	1 m²/bird
Hens in individual compartments	345 cm²/bird
Toms in individual compartments	1 m²/bird

Annex 1b: Artificial insemination

Commercial male turkeys, especially of heavy lines, are not suitable for natural mating because of their weight. Artificial insemination is therefore preferred to natural mating in the turkey industry (Glatz and Rodda, 2013). This spares the hens the stress of mating and reduces the risk of injury as well as the associated risk of infection. During natural mating, the heavy weight and sharp claws of the males cause serious feather abrasion on the plumage of the hens, causing scratches and sores on the skin on the back of the hen. For this reason, hens can also be provided with protective saddles during natural mating (VKM, 2016).

An additional advantage of artificial insemination is that the number of toms needed can be reduced, as thanks to the manual collection and subsequent dilution of the semen the ejaculate from one tom is sufficient to inseminate 10 to 16 hens (VKM, 2016).

Procedure

The first collection of semen or the first insemination of the hens is carried out 14 days after transfer to the laying barn, at the same time that the laying activity starts. In order to achieve a high fertilisation rate from the outset, the hens are inseminated three times during the first week, and then the insemination interval is reduced to once a week (de Jong et al., 2012, Hybrid, 2015). The “milking” of the toms, as semen collection is called, is also carried out once a week. The bird is fixed on its back to this end, and a mechanical clamp may be used to fix the legs. During semen collection, the cloacal region is massaged, and then a “cloacal stroke” is applied to depress the region around the sides of the cloaca (Bakst and Cecil 1983, VKM 2017). The ejaculate can be obtained through this manual stimulation of the cloaca. Artificial insemination is then performed by applying pressure to the cloacal region of the hen and having the cloaca protrude by means of an insemination tube (Hafez et al., 1997).

Animal welfare aspects

Important differences between semen collection and artificial insemination in mammals and turkeys are the frequency of the procedures, as artificial insemination requires weekly handling of turkeys (VMK, 2016). Handling involves moving and trapping the birds, placing each bird in a fixed position and performing semen collection and artificial insemination. Fixing and trapping the birds can cause physical harm and/or stress. When a large number of birds has to be inseminated, a steady influx of new turkeys is required. Crowding and/or fighting among the birds may result in scratches or wounds caused by other birds, equipment or people. The weight of the birds and the design of the collection site may also require the birds to be trailed (for a short distance). Depending on the characteristics of the ground surface, this may lead to wear and tear of the plumage. The weight and struggle of the birds can also damage the legs or wings if caught incorrectly. If a mechanical clamp is used to restrain the birds, struggling or a clamp malfunction may cause pain and/or harm (VKM, 2016).

To avoid contamination by urates and faeces during semen collection and artificial insemination, some farms deprive the birds of feed for six hours before the procedure. Feed deprivation prevents contamination but can cause stress. The birds may moreover harm each other while fighting for food when they regain access to it after a period of deprivation (VKM, 2016).

The semen collection procedure entails cloacal friction. The cloaca of affected turkeys was examined before and after single and multiple semen collections (Bakst and Cecil, 1983). 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.

Physical damage / bleeding can occur in the vagina during artificial insemination if the tube is inserted with too much force.

Turkey hens naturally try to brood and stay on the eggs in the nest, as a result of which the hen may no longer lay eggs. In order to avoid or reverse this, hens are sometimes removed from the flock and denied access to the nesting area, thereby rendering a behavioural need impossible and possibly causing stress (VKM, 2016).

Annex 2: Legal bases, further explanations

The following information makes no claim to be exhaustive and consists merely excerpts taken from the cited websites.

EU law
Specific recommendations – further explanations

Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes (2001) Recommendation concerning Turkeys[13]

A system should be considered whereby a **certificate of competence** approved by the competent authorities can be issued at least to the stockman.

The turkeys must be **inspected** thoroughly at least twice a day, whereby the animals should be made to walk in order to detect any leg problems. All facilities should have a written animal health management plan.

Injurious **pecking** between birds may be a significant problem in turkeys. Factors which could be used to help preventing or at least minimising this, include: choice of strain, quality of light, including supplementary ultra-violet light, visual barriers such as compacted straw bales and other environmental enrichment.

The **space allowance** for birds shall be set taking account of their age, sex, live weight, health and needs to move around freely and to perform normal social behaviour and shall allow the birds to:

- stand with a normal posture
- turn around without difficulty,
- defecate showing normal movements,
- flap the wings,
- show normal preening behaviour,
- perform normal social interactions,
- carry out normal feeding and drinking movement,

[13] https://www.verbrauchergesundheit.gv.at/tiere/recht/eu/EU-HaltungPuten.pdf?63xzlm

- run during at least the first five weeks, and
- escape from aggressors.

The size of the group shall be such that it does not lead to behavioural or other disorders or injuries.

Turkeys shall not be kept in **cages.**

Adequate **litter** shall be provided and maintained in a dry, friable state in order to help the birds to keep themselves clean and to dust bath, to enrich the environment, to reduce abnormal behaviour, and to reduce health problems, in particular foot, leg and breast lesions.

All buildings shall have **light** levels sufficient to allow all birds to see one another and be seen clearly, to investigate their surroundings visually and to show normal levels of activity. The minimum illumination level shall be 10 Lux at bird eye level. The lighting regime shall be such as to prevent health and behavioural problems. Therefore, after conditioning of the poults to the housing system used, it shall follow a 24-hour cycle and include uninterrupted dark and light periods, as a guideline 8 hours, but no less than 4 hours. To avoid injury to the birds, twilight periods should be provided in the dimming and raising of light.

All turkeys shall have appropriate access to adequate, nutritious, balanced and hygienic **feed** each day and to adequate supplies of fresh **water** of good quality at all times. The routine use of drugs as part of a management system to compensate for poor hygienic conditions or management practices or to mask signs of poor welfare, such as pain or distress, shall not be allowed.

When considering the establishment or replacement of a flock, the choice of the strain of bird shall be made with the aim of reducing welfare problems. **Breeding** or breeding programmes, which cause or are likely to cause suffering or harm to parent birds or their offspring shall not be practised. In particular, strains of birds whose genotype has been modified for production purposes shall not be kept under commercial farm conditions unless it has been demonstrated by scientific studies that the birds can be kept under such conditions without detrimental effects on their welfare, including their health and aspects of behaviour.

In breeding programmes, at least as much attention shall be paid to criteria conducive to the improvement of birds' welfare, including their health as to production criteria. Therefore, the conservation or development of breeds or strains of animals, which would limit or reduce animal welfare problems connected with, for instance, aggressiveness, feather pecking, mating or locomotory disorders shall be encouraged.

The **mutilation** of turkeys shall be generally prohibited; measures shall be taken to avoid the need for such procedures by changing inappropriate environmental factors or management systems, by enriching the environment and by selecting appropriate breeds and strains of birds.

If these measures are not sufficient to prevent injurious pecking, exceptions to this general prohibition may be made by the competent authority only in respect of:

- the removal of at most a third of the upper mandible, measured from the tip of the beak to the nostrils, or the trimming of the tips of both mandibles within the first 10 days of life;
- and beak trimming after 10 days of life, which shall only be performed in circumstances of veterinary need and then only by a veterinarian or under veterinary supervision when permitted by national legislation.

In any case the birds shall be able to feed normally. Birds which have their beak trimmed shall be kept in substantially brighter lighting conditions.

Examples of the legal situation in EU Member States

Austria

General provisions for poultry :[14]

In closed barns, a permanent and sufficient **air** exchange must be provided without causing harmful draughts in the animal area. For broilers and turkeys, ventilation must be

[14] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20003820

sufficient to prevent overheating of the barn and to remove excess moisture, if necessary in conjunction with heating systems.

A **light** intensity of at least 20 lux shall be achieved in the animal area of poultry barns during the light phase. There shall be an uninterrupted dark phase of at least 6 hours daily, except in poult rearing during the first 48 hours. A maximum light intensity of 5 lux is permissible during the dark phase. In the event of a change of light, smooth or gradual transitions shall be observed. The **noise** level shall be kept as low as possible. Continuous or sudden noise shall be avoided. The design, installation, maintenance and operation of ventilation fans, feeding machines or other machinery shall be such as to cause as little noise as possible.

Each housing system shall be equipped with a watering device appropriate in particular to the size of the group. If nipple drinkers or drinking cups are used, at least two of these devices shall be within reach for each group. The distribution of **feeding and watering facilities** shall ensure that all animals have unhindered access. The animals must either have permanent access to feed or be fed in portions and the feeding must be stopped at least 12 hours before the expected slaughter date. All animals must be checked at least once a day.

The professional trimming of a maximum of one third of the beak measured from the distal edge of the nostrils of chicks or poults less than 10 days old is a permitted **mutilation.**

Special husbandry requirements for turkeys:

Water shall be supplied throughout the light day.

Watering facilities shall be installed and maintained in such a way as to minimise the risk of overflow.

Elevated areas may be calculated as a usable area by a maximum of 10% of the floor space. Elevated areas are considered to be usable if the animals can use the space on and under these areas. Elevated areas may be closed or perforated.

Turkeys must have permanent access to dry, loose litter.

The maximum stocking density for turkeys is 40 kg/m².

Where outdoor access is provided, the minimum outdoor area must be 10 m²/animal.

Germany

Bundeseinheitliche Eckwerte für eine freiwillige Vereinbarung zur Haltung von Mastputen[15] (2013) [Voluntary Benchmarks for an Agreement on the Keeping of Fattening Turkeys], as well as Lower Saxony Decree on Turkey Fattening.[16]

All turkeys on the farm must be **inspected visually** at least twice a day. The flock shall be inspected by the supervising veterinarian at least once a month.

Suitable **litter** shall be provided so that the turkeys can engage in behaviour appropriate for their species such as dust-bathing and pecking. The layer of litter with which the turkeys come into direct contact must be loose and dry until the day of depopulation. The "Recommendations for foot pad health in fattening turkeys" must be followed.

All birds must have sufficient access to **feeding and watering facilities** so that unnecessary competition between them can be avoided. Feeding must be stopped at the earliest 12 hours before the expected slaughter date.

In addition to an adequate **air** exchange rate, maximum noxious gas concentrations should be considered. A maximum ammonia content in the barn air of below 10 ppm should be aimed for. 20 ppm must not be exceeded permanently.

The "Merkblatt zur Vermeidung von Hitzestress bei Puten" [Code of Practice on the Prevention of Heat Stress in Turkeys] must be complied with.

[15] http://www.lkclp.de/uploads/files/bundeseinheitliche_eckwerte_mastputen.pdf

[16] http://www.topagrar.com/news/Home-top-News-Putenmast-Meyer-fuehrt-Bundeseinheitliche-Eckwerte-per-Erlass-ein-1260244.html ; https://www.ml.niedersachsen.de/startseite/themen/tiergesundheit_tierschutz/tierschutzplan_niedersachsen_2011_2018/puten/puten-110863.html

Turkey barns must be provided with **light** openings, the total area of which must correspond to at least 3% of the barn floor space, to let in natural light so as to attain the most even possible distribution of light over the entire barn floor space. This does not apply to existing buildings approved or put into use before 1 October 2013. The artificial light must be flicker-free in accordance with the requirements specific to the species. The light intensity must be at least 20 lx at animal eye level.

Dimming possibilities for temporary darkening in case of feather pecking and/or cannibalism shall be tolerated. The blackout periods shall be recorded. The length of the **dark period** shall be at least eight hours if possible. The establishment of twilight periods is recommended. Deviations from the lighting programme are permissible during the acclimatisation period, in the exit phase or if indicated by a veterinarian. Emergency lighting for orientation (0.5 lx) may be provided.

Suitable **occupational material** must always be provided to the turkeys. Newly introduced litter material or also litter that has been worked through (e.g. wood shavings) are considered to be occupational material. In addition to loose and dry litter, at least one other changeable material, such as straw/hay in pens/baskets, straw bales or other peckable objects, such as pecking blocks, must be provided at all times. If behavioural deviations such as feather pecking or cannibalism should occur, additional occupational materials must be provided.

It is advisable to **structure** the barn so that the birds can retreat, explore and rest. Elements such as straw bales, elevated perching, shelter or an outdoor area can be used for this purpose.

The turkey keeper commits to take part in a **health control programme**. The purpose of this programme is to analyse the results of parameters relating to the passage from rearing and fattening as well as from the slaughter and meat inspection so as to obtain indicators for an assessment of animal health and welfare.

The turkey farmer plans the **stocking density** in such a way that 45 kg/m² and 50 kg/m² of usable floor space is not exceeded for turkey hens and toms respectively, even in the final phase of the fattening period. When participating in the above-mentioned health control programme, up to 52 kg/m² are permissible for turkey hens and up to 58 kg/m² for turkey toms.

If an outdoor area is permanently available to the birds as of the ninth week of life at the latest, the usable portion of that outdoor area can be allocated 50% of the permissible stocking density. Said usable area is limited to a maximum of 25% of the barn's floor space.

Denmark

The regulation on the keeping of turkeys for fattening purposes[17] contains the following provisions in particular:

- The maximum stocking density is 58 kg live weight per square metre for toms and 52 kg for hens. An average stocking density of 55 kg for toms and 48 kg for hens, calculated over the current batch and the two previous batches in the same barn, must not be exceeded, however.
- The litter must be loose and dry on the surface during the entire production period.
- The light in the barn must be sufficient for the turkeys to engage in normal behaviour. There must be a sufficient and continuous period of darkness to meet their behavioural and physiological needs. Twilight must be mimicked by a transition between light and dark long enough so that the turkeys can adapt to the changing light conditions.
- Fans and other machinery must be designed, installed, operated and maintained in such a way as to minimise noise.
- Turkeys must have daily access to sufficient, nutritious, balanced and hygienic feed and sufficient fresh water of good quality at all times. They must receive grit/gastroliths throughout the production process (except in the last week before slaughter).
- Turkeys must be inspected at least twice a day. Technical systems for feed, water, temperature control and ventilation as well as the quality of litter must be inspected at least once a day. Electrical systems that are important for the health and welfare of the turkeys must be fitted with an alarm system.

[17] Lov om hold af slagtekalkuner (Lov nr 91 af 09/02/2011). https://www.retsinformation.dk/eli/lta/2011/91

France

There are no requirements for keeping turkeys in France, even though this has been repeatedly demanded by various animal welfare organisations. The stocking density is estimated at 8 animals/m² (Welfarm, 2016). Lighting is kept mainly at 5 lux. However, in various labels (e.g. Label Rouge) the stocking density is limited to 6 animals/m², and the maximum flock size to 2,500 birds.

Annex 3: Comments on the practice of debeaking

The Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes – Recommendation concerning Turkeys, Article 24, runs as follows: "For the purposes of this Recommendation, 'mutilation' means a procedure carried out other than for therapeutic purposes and resulting in damage to or loss of a sensitive part of the body or alteration of bone structure." One point under discussion in this context is the trimming of the upper beak. This procedure is an amputation carried out by laymen without anaesthesia and has been shown to destroy or remove not only pure horn parts but also underlying tissue and to disrupt or prevent the function of the highly specialised bill tip organ permanently (Petermann et al., 1999).

Procedure

Beaks are nowadays trimmed using infrared (IR) radiation – currently said to be the least stressful method. The energy of the infrared radiation damages the tissue of the upper beak in such a way as to reduce its growth in the long term. The upper beak thus does not grow beyond the lower beak and the pointed end of the beak, which could injure other animals, is prevented from forming.

The laser ("bio-beaker") method could not meet the requirement of trimming the upper beak of day-old chicks by a maximum of 3 mm in all cases (Petermann et al., 1999). Other possibilities include beak treatment with a hot blade, where heat is applied to damage the tissue of the tip and thus reduce the growth of the upper beak. This treatment can cause minor bleeding. In addition, of the various methods, the use of a hot blade seems to cause more pain and stress as the birds cry out during the trimming process.

Cold trimming seems to be slightly less effective in preventing injurious pecking (Grigor et al., 1995). Manual beak trimming with scissors is painful for young chicks and causes bleeding wounds where bacteria can enter. The method is associated with increased mortality, which is why this procedure is no longer performed as standard practice today (Mailyan, 2019).

Animal welfare aspects

The trimming of the upper beak prevents unrestricted pecking which is specific to the species. A study by Bircher and Schlup (1991 c) on Big 6 fattening hybrids showed that for debeaked fattening hybrids, normal food intake, especially of smaller feed particles, is not possible or only possible to a limited extent. It must therefore be assumed that such fattening hybrids cannot meet their occupational need associated with feeding. Furthermore, reasons for the poor condition of the plumage in fattening turkeys include insufficient (plumage) care. The ability to groom is also directly related to the integrity of the beak used for this purpose.

On the other hand, the tissue at the tip of the beak has still not recovered its normal innervation 42 days after trimming (Gentle et al., 1995).

Pathological-anatomical and histological examinations after using the infrared method showed that not only the upper beak, but also parts of the lower beak, including the beak tip organ, are damaged in the sense of a second- or third-degree burn (Fiedler et al., 2006). Both the IR and the laser method thus cause considerable damage to the animals and presumably considerable long-lasting pain (Fiedler et al., 2006).

For the sake of animal welfare, ways must therefore be found to make mutilations of this kind to prevent feather pecking and cannibalism superfluous. To this end, scientifically supported studies should be pursued both on the breeding of lines that are less prone to these behavioural disorders and on the introduction of systems that prevent such a development by providing adequate housing conditions from the time the birds hatch (Fiedler et al., 2006).

Measures to prevent debeaking

The housing conditions of fattening turkeys should therefore be improved also in order to avoid debeaking in the near future. Although desirable due to its relevance to animal welfare and frequently postulated, a phase-out of beak trimming is considered difficult according to the current state of knowledge (Marks, 2020). Beak trimming is generally prohibited in organic farming (EU Organic Regulation, 2007) as well as in various label programmes (Label Rouge, Neuland). In Germany, various research projects on keeping turkeys with intact beaks have been carried out in recent years (e.g. Spindler and Hartung, 2007, 2013). This alternative requires a much more complex animal control than the keeping of debeaked animals.

A detailed list can be found in the recommendations of the German Lower Saxony Ministry of Food, Agriculture and Consumer Protection for avoiding the occurrence of feather pecking and cannibalism in turkeys and emergency measures in the event of such occurrence (NMELV, 2019).

Experiments by Damme and Urselmans (2013), Hiller et al. (2013) and Schulze-Bisping (2015) have shown that under the same management, injury occurred significantly more often in flocks with intact beaks than in flocks with debeaked animals. These observations lead to the conclusion that more time-intensive animal care is essential for managing non-debeaked turkeys. The entire flock should therefore be checked 3-4 times a day, and even more frequently in the event of acute cannibalism (NMELV, 2019). Intensive animal care and observation are necessary so as to enable the carer to recognise any change in animal behaviour immediately so that measures can be initiated without delay. In particular, early separation of albeit slightly injured animals seems to be indispensable (Kulke et al., 2014). Furthermore, in case of an increased occurrence of injurious pecking, additional occupational material should be made available at an early stage in order to provide the animals with alternative possibilities to act out their exploratory behaviour. Nevertheless, it cannot be ruled out at this stage that not trimming the beak tip can also be associated with higher losses, even if the experiment by Kulke et al. (2014) has shown that losses can in principle also be limited in the keeping of turkey toms with an intact beak to an extent that corresponds to the level customary in practice and known for debeaked toms.

Further investigations in practice are absolutely necessary to show whether a form of animal husbandry that is significantly more time-consuming and thus also more expensive, as described by Kulke et al. (2014) and Schulze-Bisping (2015), can be put to practice in farms. This form of optimisation of husbandry and management is nonetheless bound to lead to a significant increase in personnel costs on the fattening farms and thus entail an additional financial burden. Even if there are promising approaches at the current state of knowledge to counter the occurrence of feather pecking and cannibalism in fattening turkey husbandry, many questions still remain unanswered.

All Lower Saxon turkey farmers are already required to prove that beak trimming is temporarily indispensable for their flock, according to a Ministry circular (NMELV, 2019b). Turkey farmers in particular are to attend training courses in the current year on the

“Recommendations for avoiding the occurrence of feather pecking and cannibalism” (NMELV, 2019a), which were charted in the animal welfare plan. The Lower Saxony Chamber of Agriculture offers corresponding training courses in cooperation with other institutions, the contents whereof are recognised by the Lower Saxony Ministry of Food, Agriculture and Consumer Protection.

In any event, care must be taken to ensure that the end of debeaking, desirable as it is for animal welfare reasons, does not result in an increased number of turkeys with serious injuries due to cannibalism, as such a development would not be in line with the goal of avoiding pain for and damage to the animals on a permanent basis (Kulke et al., 2016).