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Risk assessment on welfare in turkeys

Opinion of the Panel on Animal Health and Welfare of the Norwegian Scientific Committee for Food Safety

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Assessed and approved

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Acknowledgments

The Norwegian Scientific Committee for Food Safety (Vitenskapskomiteen for mattrygghet, VKM) has appointed a project group consisting of both VKM members and external experts to answer the request from the Norwegian Food Safety Authority. The project leader from the VKM secretariat has been Angelika Agdestein. The members of the project group, Kristian Hoel (Panel on Animal Health and Welfare), Knut Egil Bøe (Panel on Animal Health and Welfare), Magne Kjerulf Hansen (Norwegian Meat and Poultry Research Center, Animalia), Andrew M. Janczak (Norwegian University of Life Sciences, NMBU) and Angelika Agdestein (VKM staff) are acknowledged for their valuable work on this opinion. Atle Løvland (Nortura) is thanked for organising a visit to a facility with turkey parent stock, where the project group were shown semen collection and artificial insemination. He also arranged for the project group to visit a facility with turkeys kept for meat production. Both farmers are also thanked for opening their doors and guiding the project group through the facilities.

Competence of VKM experts

Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third party interests. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

Table of Contents

Summary

The Norwegian Food Safety Authority (NFSA) asked the Norwegian Scientific Committee for Food Safety (Vitenskapskomiteen for mattrygghet, VKM) for a risk assessment on turkey welfare. The VKM report will be used by NFSA in assessing the need for amending the existing regulations, competence requirements, and guidelines for surveillance and control related to keeping turkeys.

Inspectors from NFSA have reported that there are serious animal welfare challenges in today's turkey production, despite the fact that producers largely comply with the existing species-specific legislation for turkeys. Compared with the legislation on broilers, current legislation on turkeys is limited and has not been revised since 2001.

VKM was asked to describe the physiological and behavioural needs of turkeys (*Meleagris gallopavo*) in general, to assess welfare risks related to living area, animal densities, air quality, bedding, feeding and watering, and lighting regimes in turkeys kept for meat production. Description of risk-reduction measures was requested specifically with regards to living area, bedding, and feeding and watering. Relevant welfare indicators for turkeys were also to be described. Additionally, assessment of welfare risks related to semen collection (SC) and artificial insemination (AI) in parent stock were requested, together with a description of relevant risk-reduction measures. Organic production of turkey meat and the genetic constitution of the hybrids kept for meat production were not included in the request. Handling and transport of day old turkeys from hatchery to farm was excluded, as was handling related to transport and slaughter of turkeys kept for meat production. Welfare aspects of parent stock other than with respect to SC/AI were also excluded from the request. Nine detailed Terms of Reference were presented to VKM. VKM appointed a project group consisting of two external experts and two members of the Panel on Animal Health and Welfare to answer the request. The Panel on Animal Health and Welfare has reviewed and revised the draft prepared by the project group and finally approved the risk assessment.

In the risk assessment, the main physiological and behavioural needs of farmed turkeys are identified and described. Today's Norwegian turkey production environment may present obstacles to the fulfilment of several of these needs, regardless of compliance with existing legislation. Wet bedding is a major hazard to turkey welfare and is a cause of foot pad lesions and other skin lesions. As these skin conditions are widespread in Norwegian turkey production, wet bedding seems to represent a high risk to turkey welfare. An important risk-reduction measure would be to minimise the likelihood of the litter becoming wet, by preventing leakages from the drinking system, by ensuring good gut health, replacing wet litter, and by establishing optimal ventilation and heating.

Additionally, several moderate welfare risks are identified, including low temperature for poults, inappropriate diet or poor quality of drinking water, failure of the drinking system, as

well as too high or too low light intensities or inappropriate lighting regimes. Also, the incorrect use of recovery pens is considered to be a moderate welfare risk related to living area, which may be reduced by introducing appropriate management guidelines. Animal welfare risks of lesser significance are associated with high temperatures, and failure of the feeding system.

In addition, several hazards for turkey welfare were identified and characterised. However, due to lack of data with regards to the exposure of Norwegian turkeys to and/or the welfare consequences of these hazards, they were not fit for a complete risk assessment. These hazards include lack of environmental enrichment, insufficient space for movement, resting, and avoidance, inappropriate stocking densities and different air quality parameters. It should be noted that the welfare hazards related to insufficient space are of increasing relevance with progressing age and size of the animals, and that hazard characterisation of different stocking densities would further be complicated by their interaction with other factors in the production unit. High levels of dust, ammonia, and other noxious gases are potential hazards for turkey welfare related to air quality, but sufficient data for risk characterisation lack.

The “transect walk” method represents a promising method for systematic on-farm registration of welfare in turkey flocks. Foot pad lesions, breast skin lesions and air sacculitis are valid animal welfare indicators, that are feasible and appropriate for recording at the slaughterhouse. Implementing systematic recording of these indicators would assist in generating an evidence-based document of the turkey welfare situation.

With regards to artificial insemination of parent stock, moderate welfare risks are associated with damage/haemorrhage inflicted by the AI procedure, as well as routine feed deprivation prior to AI. Haemorrhage caused by the SC procedure, as well as stress or injuries caused by herding/catching and handling the turkeys in connection with both SC and AI, are characterised as low welfare risks. To reduce the welfare risks when performing SC and AI, the knowledge and skills of the responsible workers are of key importance.

Key words: VKM, risk assessment, turkey, *Meleagris gallopavo*, welfare, Norwegian Scientific Committee for Food Safety, Norwegian Food Safety Authority

Sammendrag på norsk

Mattilsynet har bedt Vitenskapskomiteen for mattrygghet (VKM) om å gjøre en risikovurdering av velferd for kalkuner. Mattilsynet skal bruke VKMs risikovurdering til å vurdere behov for endringer i regelverket for hold av kalkun, kompetansekrav og tilsynsveiledere på området.

Mattilsynets inspektører melder om store dyrevelferdsutfordringer ved dagens driftsformer, til tross for at produsentene i stor grad overholder gjeldende særlige krav for kalkuner. Sammenliknet med regelverket for slaktekylling er regelverket for kalkun begrenset, og det er ikke blitt revidert siden 2001.

VKM ble bedt om å beskrive fysiologiske og atferdsmessige behov hos kalkunen (*Meleagris gallopavo*), og om å vurdere risiko for velferd relatert til oppholdsrom, dyretetthet, luftkvalitet, underlag, fôring og vanning, samt lysforhold, hos slaktekalkun. VKM skulle skissere risikoreduserende tiltak knyttet spesifikt til oppholdsrom, underlag, fôring og vanning. Relevante velferdsindikatorer skulle også beskrives. I tillegg ble VKM bedt om å vurdere velferdsrisiko, samt relevante tiltak for å redusere denne, relatert til sædtapping og kunstig inseminasjon av foreldredyr. Økologisk produksjon av kalkunkjøtt, samt genetiske faktorer hos hybridene som brukes i kjøttproduksjon, er ikke omfattet av oppdraget. Tilsvarende gjelder for håndtering og transport av kalkunkyllinger fra klekkeriet til produksjonsenhetene for slaktekalkun, samt håndtering av slaktekalkun i forbindelse med transport og slakt. Oppdraget omfatter heller ikke velferd hos foreldredyr, annet enn i forbindelse med sædtapping og kunstig inseminasjon. VKM fikk ni konkrete spørsmål og nedsatte en prosjektgruppe som besto av to eksterne eksperter og to medlemmer av Faggruppen for dyrehelse og dyrevelferd for å svare på bestillingen. Faggruppen for dyrehelse og dyrevelferd har gjennomgått og revidert utkastet utarbeidet av prosjektgruppen og har godkjent risikovurderingen.

Denne risikovurderingen identifiserer og beskriver de viktigste fysiologiske og atferdsmessige behov hos produksjonskalkun. Forholdene i dagens norske kalkunproduksjon kan gjøre det vanskelig å tilfredsstille flere av disse behovene. Fuktig strø utgjør en betydelig fare for dyrevelferden og forårsaker hudskader på tråputer og bryst. Da disse hudskadene er utbredt i norsk kalkunproduksjon, representerer fuktig strø en høy risiko for velferd hos kalkuner. For å redusere risiko, er det viktig at underlaget holdes tilstrekkelig tørt. Det gjøres ved å hindre lekkasjer fra drikkevannssystemet, opprettholde god tarmhelse, fjerne fuktig strø og sikre optimal ventilasjon og varmetilførsel.

Videre påpeker vurderingen en moderat risiko for dyrevelferden ved lave temperaturer for unge kalkuner, dårlig kvalitet på fôr eller drikkevann, svikt i tilførselen av drikkevann, for høy eller for lav lysintensitet eller feil bruk av lysprogram. Også feilaktig bruk av sykebinger utgjør en moderat risiko relatert til oppholdsrom, men risikoen kan reduseres ved at det etableres gode retningslinjer for bruk av disse. Det er lavere velferdsrisiko knyttet til høye temperaturer og svikt i fôringssystemer.

Ytterligere farer for dyrevelferden ble identifisert og karakterisert, men på grunn av mangel på data om hvordan norske kalkuner er eksponert og hva velferdskonsekvensene av disse farene er, lot det seg ikke gjøre å fullføre en risikovurdering av disse. De aktuelle farene er mangel på miljøberikelse, utilstrekkelig plass for bevegelse og hvile og for å styre klar av aggressive artsfeller, for høyt nivå av dyretetthet, samt ulike parametere for luftkvalitet. Det understrekes at farene for dyrevelferden som går på utilstrekkelig plass vil være av økende relevans med tiltagende alder og størrelse på kalkunene. Det er også viktig å påpeke at karakteriseringen av faren relatert til ulike nivåer av dyretetthet kompliseres av at denne henger sammen med andre faktorer i kalkunhuset. Høye nivåer av støv, ammoniakk og andre skadelige gasser er mulige farer for kalkunvelferden i forbindelse med luftkvalitet, men mangel på data forhindrer videre risikokarakterisering.

Metoden “transect walk” er et lovende verktøy for systematisk registrering av velferden ute i besetningene. Hudskader på tråputer og bryst, samt luftsekkbetennelse, er gode indikatorer for dyrevelferden som egner seg til registrering i forbindelse med slakting. Systematisk registrering av disse indikatorene vil kunne bidra til å dokumentere velferdssituasjonen.

Angående kunstig inseminasjon av foreldredyr er velferdsrisikoen for skader forårsaket av selve inseminasjonsprosedyren og for den rutinemessige fastingen av dyrene i forkant av denne, karakterisert som moderat. Velferdsrisiko knyttet til skader forårsaket av sædtappingsprosedyren og til stress og skader under innfangning og håndtering av dyrene i forbindelse med både sædtapping og inseminasjon, vurderes som lav. Det vil være et aktuelt risikoreduserende tiltak å stille formelle krav til kompetanse hos personell som gjennomfører sædtapping og inseminasjon.

Abbreviations and glossary

Abbreviations

AI – artificial insemination

BUT/B.U.T. – British United Turkeys (a turkey hybrid)

FDN – focal dermal necrosis (chest lesions)

FUD – focal ulcerative dermatitis (chest lesions)

FPD – foot pad dermatitis

SC – semen collection

Glossary

Aviagen is an international poultry breeding company producing turkey hybrids.

Animalia is the Norwegian Meat and Poultry Research Center, an industry owned organisation working for strengthening the Norwegian meat and poultry production throughout the value chain.

Brooder rings are rings of cardboard that reduce the available area for smaller groups of chicks and poults during the first days of life to make it easier to maintain a sufficient temperature and to help the poults to locate feed and water.

Broilers are chickens kept for meat production.

Foot pad scoring is a method for evaluating the degree of development of foot pad lesions in poultry.

Hendrix Genetics is an international multi-species breeding company producing turkey hybrids.

Hens are female turkeys.

Litter is water absorbing bedding material on the floor of the poultry stable, usually wood shavings and saw dust.

Perching is when birds rest in an elevated place.

Poults are juvenile turkeys.

Preening is the smoothing or cleaning of feathers using the beak.

Roosting is when birds rest or sleep.

Toms are adult male turkeys.

Background as provided by the Norwegian Food Safety Authority

In the event of doubling of the maximum production on a farm during one year without specific permission from the Ministry of Agriculture and Food, NFSA had been asked by the Ministry of Agriculture and Food to assess the need for legal measures to safeguard the welfare of turkeys. In the opinion of NFSA, doubling of production volume will neither significantly alter the current farming conditions for turkeys nor will it change their welfare situation. There is, however, a need to revise the legislation on keeping poultry, with a view to achieving improvements. Compared with the current legislation on broilers, the existing legislation on turkeys is limited and has not been revised since 2001.

Inspectors from NFSA have reported that there are serious animal welfare challenges in today's production, despite the fact that producers largely comply with the existing species-specific legislation for turkeys. Lesions on the foot pads, heavy animals with chest lesions, as well as problems related to air quality, quality of bedding, and inappropriate routines for handling sick and injured animals are specifically mentioned. Skin lesions, with special focus on foot pad lesions of turkeys, were assessed in a mapping project by NFSA during the period 2009-2013. The extent of lesions was assessed and categorized in the same way as routinely done with broilers. Of all the inspected flocks, 13 % had a foot pad score >110, which is the most severe category. All flocks contained birds with foot pad lesions. The mapping project also revealed that 11 % of the birds with foot pad lesions also had chest lesions. Another local NFSA carried out a local surveillance project in which 100 feet of each flock slaughtered at Norsk Kylling AS were assessed in the same way. The findings from this local project were that approximately 39 % of the inspected turkeys had serious foot pad lesions. Both reports from these surveillance projects concluded that skin lesions constitute a serious welfare problem in turkeys.

The Norwegian turkey industry states that turkeys are a more demanding species to keep than broilers, resulting in management factors and staff competence being of even more importance in this production. Turkeys seem to be more sensitive than broilers regarding, e.g., air quality and change of feed. They also live longer than broilers, resulting in increased challenges with e.g., quality of bedding and indoor climate, due to accumulation of droppings. According to the industry, the most common health problems in turkeys are air sac problems (various stages of inflammation in the air sacs) and chest blisters. Other common problems include lameness as a result of joint problems or misalignment of joints and necrotic enteritis caused by *Clostridium perfringens*. A rather large proportion (2014: 13.9 %; 2015, 4.9 %) of Norwegian turkey flocks are treated with antibiotics for this disease. Mortality and carcass condemnation rates are higher for turkeys than for broilers.

Keeping turkeys is not specifically regulated in the EU, but is covered in the directive concerning the protection of animals kept for farming purposes (Council Directive 98/58/EC). This Directive is implemented in the Norwegian Regulation 3. July 2006 no. 885 on welfare for production animals (hereafter referred to as Regulation on production animals). Furthermore, keeping turkeys is regulated in Regulation 12. December 2001 no. 1494 on keeping of hens and turkeys (hereafter referred to as Regulation on keeping of poultry) applies, in which minimum requirements for keeping turkeys are laid down. The Regulation on keeping of poultry aims to promote good health and welfare for poultry, and to ensure that measures are taken to fulfil their natural needs. The Regulation on keeping of poultry contains general requirements for, e.g., personnel competence and design of poultry production systems, and prohibits routine mutilation procedures. Furthermore, the Regulation on keeping of poultry contains chapters that are specific for keeping laying hens, broilers, and turkeys. In comparison with the chapters on laying hens and broilers, there are few species-specific requirements for turkeys. Paragraph 35d states the requirements on maximum stocking density and minimum ventilation capacity: *"For turkeys kept for meat production, animal density shall not exceed 38 kg live weight/m^2 when the animals' average live weight is below 7 kg. When average live weight exceeds 7 kg, animal density shall not exceed 44 kg/m^2. The ventilation capacity for turkeys shall be at least 3.4 m^2 air exchange per kilo live weight per hour."*

Denmark and Sweden have more detailed regulations on keeping turkeys than Norway. Limits have been set for levels of different variables, such as ammonia and carbon dioxide, temperature, and light intensity. Maximum stocking density in Denmark is very high (58 kg/m^2 for toms and 52 kg/m^2 for hens). Sweden generally allows 30 kg/m^2, but up to 45 kg/m^2 is permitted for producers who are enrolled in an approved control programme.

Terms of reference as provided by the Norwegian Food Safety Authority

The Norwegian Food Safety Authority (NFSA) would like to obtain greater knowledge on animal welfare risks in today's production of turkeys (*Meleagris gallopavo*) in Norway and relevant measures for risk reduction. This report will be used in assessing the need for amending the existing regulations, competence requirements, and guidelines for surveillance and control within this field.

The Norwegian Scientific Committee for Food Safety (VKM) is asked to assess the risk that turkeys kept for meat production in standard production systems, and in accordance with existing legislation, are exposed to strain or stress resulting in reduced welfare. Relevant measures for risk reduction are to be described.

Further, VKM is asked to assess the risk that turkey parent stock is exposed to strain or stress resulting in reduced welfare during performance of today's standard routines for insemination, including handling.

Organic production of turkey meat and the genetic constitution of the hybrids kept for meat production are not included in the request. Handling and transport of day old turkeys from hatchery to farm is excluded, as is handling related to transport and slaughter of turkeys kept for meat production. Welfare aspects of parent stock other than with respect to SC/AI are also excluded from the request.

The specific Terms of Reference (ToR) to be answered are the following:

ToR 1 Physiological and behavioural needs

What are the physiological and behavioural needs in farmed turkeys (*Meleagris gallopavo*)?

ToR 2 Living area, equipment and fixtures

The living area, equipment, and fixtures for turkeys shall, according to legislation, be designed to safeguard the animals' physical and mental needs, including behavioural needs, and to protect them from unnecessary stress, pain, and suffering (Regulation on keeping of poultry § 4, 7 and Regulation on production animals § 7).

a. What is the risk that the animals' physical and mental needs are not fulfilled?
b. What is the risk that the animals are subjected to stress, pain, suffering, or other strains resulting in reduced welfare?
c. What measures for risk reduction could be applied?

ToR 3 Animal density

For turkeys kept for meat production, animal density shall not exceed 38 kg live weight/m^2 when the animals' average live weight is below 7 kg. When the average live weight exceeds 7 kg, animal density shall not exceed 44 kg/m^2 (Regulation on keeping of poultry § 35d).

a. What is the risk that today's requirements on stocking densities compromise animal welfare? Both weight categories, below and above 7 kg, should be assessed.
b. What level of stocking density would fulfil the animals' physical and mental needs (ref. ToR 1)?

ToR 4 Air quality

According to current legislation, ventilation, dust, noise, temperature, air humidity, and gas concentrations shall be kept at levels that are not harmful to the animals. The ventilation capacity for turkeys shall be at least 3.4 m^3 air exchange per kilo live weight per hour (Regulation on keeping of poultry § 35d).

a. What is the risk for reduced welfare when adhering to today's requirements for ventilation capacity?
b. At which levels of dust, noise, temperature, air humidity, and gas concentrations is turkey welfare impaired?

ToR 5 Bedding

Foot pad lesions and chestburns as consequences of unsuitable bedding seem to be widespread in turkey production. The bedding shall be kept sufficiently dry, and when new animals are introduced to the building, new bedding material of suitable quality and quantity shall be provided to stimulate the animals to peck, kick, and dust bathe (Regulation on keeping of poultry § 20).

a. What are the main risk factors for reduced animal welfare as a consequence of unsuitable bedding?
b. What measures for risk reduction could be applied?

ToR 6 Feeding and watering

The amount of feed and the feeding shall be adequate and comprised to fulfil the animals' needs in all circumstances. The feed shall ensure satiation (Regulation on keeping of poultry § 16).

a. What is the risk for reduced animal welfare by applying today's feeding systems, feed composition, and feeding routines?
b. What measures for risk reduction could be applied?

ToR 7 Lighting regime

As a VKM report already exists on this subject (from 25.06.2008), NFSA requests that reference be made to this should there be no additional scientific literature on the subject.

According to regulations, living area for poultry shall be sufficiently lit for the animals to be able to perform normal activities and to see each other clearly. Periodic dimming, or dimming of light in partial areas, is allowed when suitable to reduce the occurrence of health defects or behavioural problems. The lighting regime shall, after the first few days of adaptation, follow a 24-hour light/dark cycle and contain an uninterrupted dark period of at least 8 hours (Regulation on keeping of poultry § 12).

Aviagen recommends brightness of between 10-20 lux, and the industry claims that turkeys require a minimum of 5 lux to see each other clearly.

a. What is the necessary brightness for turkeys to carry out normal activities and see each other clearly?
b. Is there a risk of reduced animal welfare when using the level of brightness given in ToR 7a, for instance increased risk of pecking?
c. Is there a risk of reduced animal welfare when using the stated recommendations on brightness from Aviagen or from the industry?

ToR 8 Animal welfare indicators

All animals shall be inspected at least twice daily and more often when needed. Special attention shall be paid to detect indicators of poor welfare or health in the animals (Regulation on keeping of poultry § 16).

a. Which indicators are suitable to consider welfare in turkeys? Indicators at both the individual level and flock level, and at the farm and in the slaughterhouse, should be addressed.
b. Which animal-based welfare indicators could be suitable for systematic registration of the welfare level of flocks? Specifically, NFSA would like an opinion on whether foot pad dermatitis is a suitable indicator for turkeys that could be used in the same way as it is for broilers.

ToR 9 Artificial insemination of parent stock

Parent stock is regularly inseminated artificially. According to the Regulation on production animals (§ 12), breeding, including the use of natural or artificial breeding methods, shall not be carried out if it results, or may result, in suffering or wounds. This regulation does not, however, prohibit use of certain methods that might inflict minimal or brief suffering or wounds.

a. What is the risk of reduced animal welfare due to using artificial insemination (AI) of turkey parent stock?
b. What is the risk of reduced animal welfare due to semen collection (SC) from parent stock?
c. What measures for risk reduction could be applied?

Assessment

1 Introduction

The turkey (*Meleagris gallopavo*) belongs, taxonomically, to the sub-family Meleagridinae of the family of Phasanidae in the order Galliformes, and is native to the forests of North America. The earliest evidence of domestication of the turkey has been dated to over 2,000 years ago, in the ancient Maya-world (Thornton et al., 2012). The domestic turkey was later brought to Europe by Spanish explorers after the discovery of North America (Parkhurst and Mountney, 1988). As a result of domestication, distinctive breeds were developed, and, from the 1940s, intensive farming has been associated with turkey production. Today's industrial turkeys are crossbred hybrids produced by international companies, e.g. Aviagen™ and Hendrix Genetics™. British United Turkey BUT10 and Nicholas 300 are examples of commercial hybrids that are produced and distributed internationally for the purpose of meat production.

1.1 Turkey production in Norway

Norway has a rather long history of keeping and breeding Bronze turkeys, going back to the 1700s (Genressursutvalget/NIBIO, 2001). Official breeding stations existed for this breed from the 1920s until 1960. In contrast to today's industrial turkeys, the Bronze turkey is fully capable of natural mating. However, keeping Bronze turkeys in Norway today is largely associated with hobby purposes, whereas the meat industry uses commercial turkey hybrids.

Industrial production of turkey hybrids has a relatively short history in Norway (Lysaker, 2002). In the 1950s, Norwegian production was based on turkey import from Sweden, but from the 1970s, breeding of industrial turkeys was organised on a national level. However, nationally organised breeding ceased in 1993 and was replaced by import of parent stock.

Today, Norwegian industrial turkey production is based on two hybrids from Aviagen™, BUT10 and Nicholas 300. In Norway, production of turkeys relies on a supply of day-old turkey poults from national parent stock. However, parent animals are imported. In 2014, a total of 18,730 day old parent turkeys originating from Great Britain were imported on seven occasions (KOORIMP/KIF, 2015).

In 2014, there were 62 producers of turkey meat in Norway (Landbruksdirektoratet, 2015). During 2014, there were 1 369,170 Norwegian turkeys hatched (Animalia, 2015). In 2014, a total of 821,910 poults were introduced to turkey meat production facililities, and a total of 1 245,554 turkeys were slaughtered, giving 10,576 tonnes of meat. In 2013, 1.3 % of the produced turkey meat came from organic production. For 2014, however, production data on organic turkey meat are lacking (Animalia, 2015).

1.1.1 Keeping turkeys for meat production

Turkeys kept for standard meat production are typically raised in all-in/all-out production systems, in indoor free-range facilities, with bedding material and *ad libitum* access to feed and water. Turkey poults may be gender sorted at the hatchery and raised in separate groups. Toe-trimming and beak-trimming, as performed at this stage of turkey production in several other countries, is prohibited by Norwegian legislation (Regulation on keeping of poultry, § 21; (Norwegian Ministry of Agriculture and Food, 2001). Norwegian turkey hens are slaughtered at the age of 12 weeks at a slaughter weight of ~5.8 kg, whereas turkey toms are further reared to an average of 19.5 weeks and a weight of ~13.5 kg (Animalia, 2015).

Turkey poults leave the hatchery directly after hatching and are introduced to a thoroughly sanitized production unit. However, getting turkey poults established in their new environment is not as easy as with broiler chicks and laying hen chicks, and substantial efforts are required in order to succeed. Cardboard brooder rings are commonly used Norwegian turkey houses for at least the five first days of production in order to provide the turkey poults with an appropriate environment and keep them close to the heat source, and with food and water easily accessible. Other approaches to room sectioning may also be applied. Starter rooms (smaller rooms with more economic climate control than in the entire poultry house) are used by 1/3 of the Norwegian turkey farmers (mostly in the Trøndelag region).

Figure 1.1.1-1 Two-week-old BUT10 turkeys. Photo: VKM

1.1.2 Parent stock

Turkey chickens are supplied by breeding facilities and hatcheries. Parent stock in breeding facilities is kept for ~54 weeks, and thus these birds have a significantly longer life than growing turkeys in meat production facilities. Breeding is based on artificial insemination, which is unique within the poultry industry. This is practiced because natural mating is difficult for the heavy toms and puts the hens at risk of injury (Wageningen UR Livestock Research, 2010). Breeding toms are kept together in floor pens, and semen collection is performed in connection with insemination of the hens.

Sexual maturity is reached when turkeys are between 28 and 30 weeks old (Aviagen, 2013). Hens are inseminated weekly from the age that they start producing eggs, and will lay approximately 100 eggs during the following laying cycle period of ~24 weeks. The production of a fertile egg requires 24–32 hours. Eggs are collected daily, transported to the hatchery, and stored at 13 °C and 70 % humidity until they are placed in the incubator. The storage time prior to incubation might be adjusted within a restricted time span, depending on the requirement for turkey poults (BUT10 Manual, http://www.aviagenturkeys.com/en-gb/products/b-u-t-10). The poults hatch on the 28th day of incubation.

1.1.3 Legislation for keeping turkeys in Norway

The Norwegian Animal Welfare Act (Norwegian Ministry of Agriculture and Food, 2009), which aims at promoting animal welfare and respect for animals, also includes birds. In Norwegian turkey production, the following government regulations also apply:

- Regulation on welfare in production animals
- Regulation on keeping of poultry

In the EU, keeping turkeys is not specifically regulated, but is covered by the Council Directive 98/58/EC concerning the protection of animals kept for farming purposes. This directive is implemented in the **Regulation on welfare in production animals** (Norwegian Ministry of Agriculture and Food, 2006) that addresses good health and wellbeing in production animals.

The **Regulation on keeping of poultry** (Norwegian Ministry of Agriculture and Food, 2001) defines the minimum requirements for keeping turkeys in Norway, with the aim of facilitating good health and wellbeing in poultry and ensuring that the animals' natural needs are met. This regulation contains general requirements for competence and production systems, and also prohibits routine mutilation procedures according to § 21. However, there are relatively few specific requirements for turkeys, compared with the quantity of specific requirements for laying hens and chicken broilers, and merely details the limits for maximum stocking density and minimum ventilation capacity, contained in § 35d. In contrast, Denmark has a law regarding keeping turkeys for meat production (Ministry of Environment and Food of Denmark, 2011b), on which the Regulation on keeping turkeys kept for meat production (Ministry of Environment and Food of Denmark, 2011a) is based. Within this regulation, more details are provided with regards to keeping turkeys. In addition to defining maximum stocking densities, they include limits for levels of different variables, such as ammonia, carbon dioxide, temperature, and luminous flux density. The Swedish legislation also addresses turkeys to a somewhat greater extent than the Norwegian legislation (Swedish Board of Agriculture, 2010).

The Norwegian Agricultural Quality System, KSL (Kvalitetssystemet i landbruket) is organised by the Norwegian independent foundation Matmerk (www.matmerk.no) and acknowledged by the Norwegian Food Safety Authority as a national standard for the primary production branch. The KSL standard comprises guidance protocols and corresponding checklists to ensure adherence to governmental legislation. These also exist for poultry (Matmerk, 2015).

1.2 Welfare challenges in turkey production

According to NFSA, lesions on the foot pads, heavy animals with chest lesions, as well as problems related to air quality, quality of bedding, and inappropriate routines for handling sick and injured animals are reported to be important challenges in rearing turkeys in Norway (see the Background chapter, p. 13).

According to Animalia (http://www.animalia.no/Dyrevelferd-og-dyrehelse/Helsetjenesten-for-fjorfe/Dyrevelferd/Kalkun/Helseutfordringer/) and NFSA (Maria Veggeland, pers. comm), based on supervisions on farm level and reports from the meat inspection at the slaughterhouses, air sacculitis, circulatory diseases, skin and foot pad lesions, gizzard erosions and lameness are reported to be important welfare challenges in turkeys kept for meat production. A report from NFSA (Norwegian Food Safety Authority, 2015) shows that 39.4 % of turkeys delivered to one slaughterhouse during the autumn 2013 had severe foot pad lesions. Additionally, necrotic enteritis, caused by *Clostridium perfringens*, requires antibiotic treatment in many Norwegian turkey flocks. The occurrence of these conditions reflects the welfare of turkeys kept for meat production, which are therefore considered to be particularly challenging compared with broilers.

According to Gjensidige Insurance (Torfinn Jæger, pers. comm) air sacculitis diagnosed at the slaughterhouse is the most important claim in turkey production during the last decade with a total compensation of 4 million NOK in 27 cases. The second most important claim is suffocation by crowding during the 8 hour dark period. This claim has during the same period caused compensations of 1.6 million NOK.

In comparison with broilers, turkeys kept for meat production have a relatively long life in the production unit. Norwegian numbers on mortality, as well as on meat condemnation rates, are consistently higher in turkeys than in broilers (Animalia, 2015).

During turkey meat production, animals gain weight from 60 g to 5.5 kg (hens) - 13.5 kg (toms), the animal density and excretion therefore increase. Even if new litter is supplemented during the growth period, the original bedding is not usually changed. Together these factors put a strain on foot pads and airways in particular, and constitute a complex welfare challenge. This is further elaborated in Chapter 2, Hazard identification and characterisation, of this risk assessment. Other possible hazards for welfare in turkeys are also outlined in the same chapter.

1.3 Remarks on the scientific literature on turkey welfare

In general, the volume of relevant literature on turkey welfare is limited. Scientific studies on turkeys are often performed only on certain hybrids, and, although the hybrids are very similar, caution must be taken when extrapolating the findings from one hybrid to another. Selective breeding of industrial turkeys has resulted in animals increasing in size and weight over time and in enhanced growth rate and feed utilisation. Therefore, it is essential that the relevance of older studies to today's turkeys are subject to critical assessment.

1.4 Natural behaviour in turkeys

Wild turkeys normally live in stable social groups composed of one sex (Bessei, 1999). Each group of birds has a social hierarchy formed during rearing (Bessei, 1999). Males and females normally meet only during the breeding season (Bessei, 1999). Although group size varies, groups of several hundred birds have been observed during the winter (Bessei, 1999). Wild turkeys are omnivores, and their diet includes a wide variety of both plant and animal origin (Bessei, 1999). Wild turkeys cover an area of up to 13 km around the area in which they roost (Bessei, 1999). Standard turkeys used for outdoor production are excellent flyers and can cover large distances (Grimes et al., 2007).

Roosting is an antipredator strategy that is necessary for the survival of wild turkeys and may influence their preference for habitats near rivers and creeks (Bessei, 1999). Although wild turkeys have previously been reported to show no fear of humans (Dickson, 1992), they are extremely shy today (Dickson, 1992).

Genetic factors related to growth rate are associated with differences in behaviour, reactivity of the hypothalamic pituitary adrenocortical axis (corticosterone secretion in response to stress), and immune activity (heterophil:lymphocyte ratios in response to *Escherichia coli* challenge) (Huff et al., 2007). Modern breeding may focus on a balanced selection for health, fitness, welfare, and production traits (Swalander, 2012). Kowalski et al. (2002) showed that birds from the lighter and more slowly growing strain BUT9 were more resistant to stress than Big 6 turkeys. BUT9 had greater motor activity, higher initial levels of catecholamines in the blood, and heavier adrenals, but lower increases in corticosterone and glucose in response to stress (Kowalski et al., 2002).

A study by Sherwin and Kelland (1998) gives an overview of some of the normal behaviours of conventional male BUT8 turkeys under conditions in which group size and stocking density should not limit the expression of behaviour. Birds studied by Sherwin and Kelland (1998) were from four to 22 weeks of age and housed as pairs in pens measuring 3.0 m x 3.6 m. Throughout the study, the proportion of both the time spent drinking and the time spent pecking other birds was constant. However, with time, the proportion of time spent sleeping, pecking at the environment, wing flapping, and running decreased. Time spent stretching, on the other hand, increased during the study. Time budgets for feeding, standing, sitting, walking, strutting (a sexual courtship display), preening whilst standing, and preening whilst sitting, varied throughout. Changes in activity over time are explained by Sherwin and Kelland (1998) as being possibly due to increased age or to musculoskeletal weakness. At 18 weeks of age, turkeys spent 30 % of their time strutting. The turkeys were observed to behave socially. In contrast to that which is normally observed for laying hens, dust bathing and ground scratching whilst feeding were not observed at all. Injurious pecking was infrequent, but might have been due to the small group size and low stocking density.

Conventional female BUT6 turkeys use elevated platforms for resting during the earlier parts of their lives, but use of such structures declines with increasing age (Spindler and Hartung, 2009). An overview of normal behaviour in female BUT8 turkeys housed at production-relevant densities is also provided by Hughes and Grigor (1996). Ten to 11 birds per pen were housed in 2.4 m x 1.5 m pens and studied from one to 12 weeks of age. The findings differ from those of Sherwin and Kelland (1998), particularly with regards to pecking other birds, which decreased from 10 % of observations at two weeks of age to 2 % of observations at 12 weeks of age. In agreement with Sherwin and Kelland (1998), Spindler and Hartung (2009) observed no dust bathing behaviour, although preening, which is part of the dust bathing sequence in laying hens, was observed in around 12 % of observations.

1.5 Physiological and behavioural needs of turkeys

Physiological needs are mostly the same in turkeys as in all warm-blooded animals and human beings. To describe all these, is as far as the project group considers, beyond the scope of this report. Anyway, some the of the physiological needs are challenged to a great extent in animal holdings in general and in commercial turkey production because the animals are confined in a closed area and are dependent on the environment that they are provided by the farmer.

Turkeys need to regulate their body temperature to provide normal functions of the body. They need a constant supply of drinking water, as well as feed formulated according to their nutritional requirements. These vary according to their genetic constitution.

This overview of physiological and behavioural needs of turkeys starts with a summary of basic concepts in order to frame later details in a coherent theoretical context. Motivation refers to different physiological and psychological processes controlling the behavioural and physiological changes that occur (Fraser and Broom, 1997). Motivation can be visualised as a variable intervening between stimulus and output variables, as exemplified in Figure 1.5-1 for thirst, allowing one to refer to thirst, instead of hours since the last drink, amount of dry food consumed and the amount of salt ingested, in the causation of drinking behaviour.

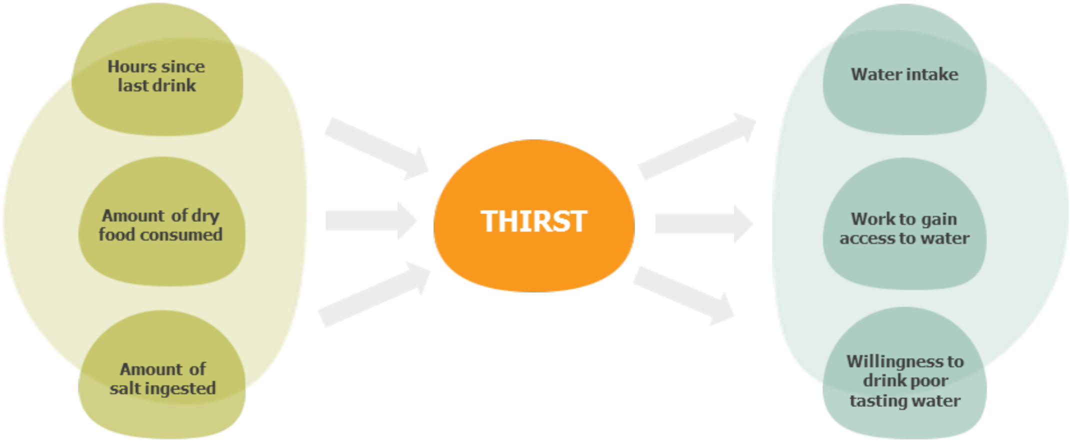

Figure 1.5-1 A schematic presentation of motivation exemplified by indicating the relationship between input and output variables and simplified by referring to the motivation 'thirst' (the motivation to drink refers to the need to drink water). Modified from Miller (1959).

"Needs" refers to specific deficiencies in an animal (e.g., the need for water) that can be remedied by obtaining a particular resource, or responding to a particular environmental or physiological stimulus (Fraser and Broom, 1997). All needs have interlinked psychological, behavioural, and physiological components. Maslow originally proposed a distinction between human physiological needs that are necessary for survival, as opposed to other needs that are more psychological and social in nature (Maslow, 1943). This corresponds to ultimate needs as defined by Dawkins (1983) that are necessary for survival, as opposed to proximate needs that do not reduce the likelihood of survival if they are not fulfilled. Examples of physiological needs are the need for feed, water, physical movement, sleep, excretion, and ambient temperatures that allow the maintenance of normal body core temperatures. Examples of proximate or behavioural needs may be the performance of specific behaviours that the animal perceives as being important, even though deprivation causes no clear adverse effects on health. One example is dust bathing in laying hens. Animals are normally motivated to express behaviour that satisfies their needs. A need that is not satisfied generally causes frustration and suffering, and reduces welfare irrespective of whether it is physiological/ultimate or behavioural/proximate. Therefore, no differentiation is made between physiological and behavioural needs in the present risk assessment.

The specific physiological and behavioural needs of turkeys are summarised below. Further descriptions of relevant needs are provided in this chapter, in Chapter 1.4, and in Chapter 2, Hazard identification/characterisation and exposure.

- Turkeys need clean water to drink.
- Turkeys need feed that has been formulated according to their nutritional requirements.
- Turkeys need fresh air of appropriate humidity and without harmful levels of noxious gases and dust.

- Turkeys need an environment with a temperature range that allows them to regulate their body core temperature. This must be combined with an appropriate relative humidity.
- Turkeys need to see. Turkeys see light in the UV range and it has been claimed that light in this range facilitates individual recognition. Turkeys, as laying hens, are likely to need a minimum illumination of 5 Lux in order to see functionally, but show a preference for higher light intensities during the light cycle. It is uncertain whether turkeys need complete darkness in order to sleep.
- Turkeys need to rest and sleep in order to maintain normal biological function. Wild turkeys roost in trees to sleep or avoid predators and can be assumed to feel safer (see previous point) when allowed to perch at night.
- Turkeys need to use their muscles for walking, standing, and ground pecking.
- Turkeys need to peck in order to eat and may need to peck in connection with exploration of the environment.
- Turkeys need to preen to keep their plumage in shape.
- Turkeys need the possibility of avoiding and escaping other aggressive birds.
- Turkeys may need litter to scratch and dust bathe.
- Turkeys may need to sit on their eggs to brood.
- Turkeys may need grit in a similar manner to chickens (no studies addressing this requirement in turkeys are available).

1.6 Semen collection and artificial insemination

Commercial turkey production requires weekly insemination of turkey hens, whereas wild turkeys mate only a few times per year (Wageningen UR Livestock Research, 2010). Commercial turkey toms are heavy and not suited for natural mating, as this would inflict injury on plumage and skin of hens. Artificial insemination (AI) is thus preferred to natural mating in the turkey industry. By using AI in parent stock, fewer male turkeys are needed.

Important differences between semen collection (SC) and AI in mammals and turkeys are the frequency of the procedures and the number of animals per flock. ”To grasp the magnitude of AI in the turkey industry compared to that of livestock, a hypothetical flock of 500 breeder hens inseminated with 100 µl of diluted semen (1:1) twice a week before the onset of egg production and once weekly thereafter for the 24 week of egg production would entail 13.000 inseminations using 650 ml of semen. It should be apparent with these numbers, that semen collection and hen inseminations are labour intensive as each male and female must be handled each week” (Bakst and Dymond, 2013).

Handling includes moving and catching the birds, placing each bird in a fixed position, and performing the SC/AI procedure.

Placing the bird in a fixed position for SC/AI can be done with or without the help of a mechanical clamp to fasten the legs.

Semen collection involves massaging the cloacal region to achieve phallic tumescence. This is followed by a ”cloacal stroke”, squeezing the region surrounding the sides of the cloaca to eject the semen (Bakst and Dymond, 2013) (Figure 1.6-1).

Figure 1.6-1 Semen collection from a breeding tom. Photo: VKM

Artificial insemination is performed by injecting a tube into the vagina after pushing up the tail and applying pressure to the abdomen causing the cloaca to evert and the oviduct to protrude (Figure 1.6-2). The vagina of the turkey is coiled and the straw should be inserted until resistance is felt, followed by release of the semen as the straw is withdrawn.

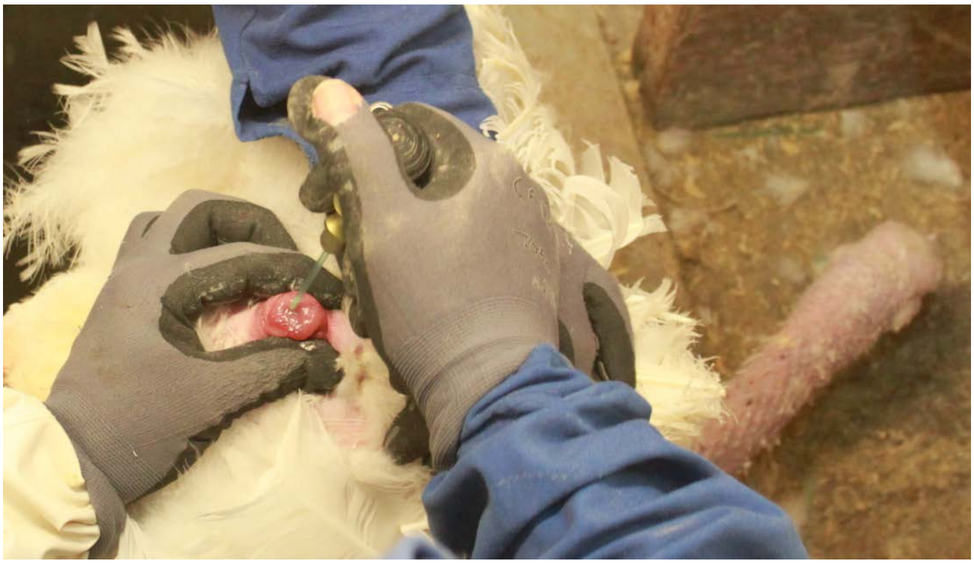

Figure 1.6-2 Artificial insemination of a turkey breeder hen. Photo: VKM

To avoid pollution from urates and faecal material during SC and AI, some farmers deprive the birds of feed for six hours before the procedure.

Turkey hens tend to be broody and want to stay on the egg(s) in the nest. This may result in the hen ceasing to lay eggs ("getting tight"). To avoid or reverse this, hens may be removed from the flock and deprived of access to the nesting area.

Each breeding turkey is a valuable individual. The production of hatching eggs (and eventually turkey meat) depends upon obtaining fertile eggs from the birds. All breeding houses for turkeys are therefore equipped with several small pens without nest boxes that can be used for housing broody hens in order to prevent expression of brooding. They are also used to house birds that need to recover from physical damage, or mild symptoms of disease, or for individuals that appear to be in poor condition. The purpose is to provide the birds with a quiet place for recovery and to facilitate inspection by the animal keeper.

Artificial insemination may have positive impacts on the welfare of today's turkey hybrids used in the industry. Because of the heavy weight and sharp claws of the toms, natural mating causes serious wear to the hens' plumage, and inflicts scratches and wounds to the skin on the back of the hen. For this reason, hens may be supplied with protective saddles during natural mating.

1.7 Animal welfare indicators

All animals shall be inspected at least twice daily and more often when needed. Special attention shall be paid to detect indicators of poor welfare or health in the animals (Regulation on keeping of poultry § 16).

The Welfare Quality Network has developed welfare assessment protocols for cattle, pigs and for poultry (Welfare Quality®, 2009), but the poultry assessment protocol only involves broiler chickens and laying hens and not turkeys. The protocol for poultry describes collection of data both on-farm and on slaughterhouse. Recently, the European AWIN-project has developed and published a welfare assessment protocol for turkeys to be used on-farm using animal-based indicators (AWIN, 2015). This protocol actually includes the "transect walk" method (see below).

Marchewka et al. (2015); Marchewka et al. (2013) developed an animal-based on-farm welfare assessment protocol called the "transect method" or "transect walks" (TW). The basis of the method is that each turkey house is subdivided longitudinally into four transects. Two observers walk slowly along the transects and record all birds in predefined categories, such as immobile, lame, head wounds, dirty, featherless, etc. The method is promising as the scores obtained correlate well with results obtained by methods based on individual animal scoring and this is also confirmed in broiler farms (Marchewka et al., 2013).

In Denmark, the authorities have worked out instructions for animal welfare inspections in turkey herds. These instructions especially focus on space allowance, feeding and watering systems, light and litter quality, in other words resource-based welfare indicators. In addition, the inspectors are supposed to assess the plumage of the turkeys, difficulty of walking and manure consistency (animal-based welfare indicators). However, no specification of an observation protocol is given.

On-farm welfare indicators

Both data on culling and mortality recorded on farm is used as a welfare indicator for broiler chickens (Welfare Quality®, 2009) and is categorized as management-based welfare indicators, and should also be used for turkeys (Table 1.7.1).

The AWIN Turkey welfare protocol (AWIN, 2015) has been used and data collected on 26 farms (44 flocks). The protocol is based on the “transect walk” method and includes 13 animal-based welfare indicators (Table 1.7-1). Each welfare indicator are described in detail in the report, and the need for proper training of the observers is underlined.

Table 1.7-1 Animal welfare indicators in the AWIN-protocol (AWIN, 2015).

Welfare principle	Welfare criteria	Welfare indicators
Good feeding	Absence of prolonged hunger	Small size
	Absence of prolonged thirst	Small size
Good housing	Comfort around resting	Dirtiness
	Thermal comfort	Featherless
	Ease of movement	Not available
Good health	Absence of injuries	Head wounds
		Back wounds
		Tail wounds
	Absence of disease	Immobility
		Lameness
		Small size
		Sick
		Terminally ill
		Dead
	Absence of pain	Lameness
Appropriate behaviour	Expression of social behaviour	Featherless
		Mating
		Head wounds
		Back wounds
		Tail wounds
	Expression other behaviours	Not available
	Good human-animal relationship	Not available
	Positive emotional state	Not available

Drinker space and stocking density are important resource-based welfare indicators also used for broiler chickens (Welfare Quality®, 2009) and should definitely be used also for turkeys (Table 1.7-1). Both drinker space and stocking density are evaluated in relation to recommendations or national regulations. Litter quality could be scored on a scale from 0 (completely dry and flaky) to 4 (sticks to boots) as used for broiler chickens (Welfare Quality®, 2009).

Footpad lesions and breast skin lesions in commercial turkey production has been investigated in several studies (Bergmann et al., 2013; Krautwald-Junghanns et al., 2011; Mitterer-Istyagin et al., 2011) and are important animal-based welfare indicators. Both these indicators involve handling of the animals and are time-consuming and labour demanding. Lameness, defined as birds walking with obvious difficulty, are used by Marchewka et al. (2015) and is an indicator that is appropriate to include in an on-farm protocol. In broiler chicken (Welfare Quality®, 2009) lameness is related to a gait score from 0 (normal, dexterous and agile) to 5 (incapable of walking). Fournier et al. (2015) used a similar scoring system for turkeys with a scale from 0 to 4.

Wounds on head, back and vent was used as animal-based indicators by Marchewka et al. (2015), and wounds at head had a much higher incidence rate than wounds at back and vent. Marchewka et al. (2015) also scored plumage cleanliness. They used no differentiated scoring but only scored bird as dirty if “very clear and dark staining of the back, wing, and/or tail feathers of the bird”. Further, featherless was scored if birds were missing feathers on the majority of the back area, including the wings (Marchewka et al., 2015).

Avoidance Distance Test (ADT) and Qualitative Behaviour Assessment (QBA) are described and are being used in broiler chicken (Welfare Quality®, 2009), but are apparently not developed for turkeys.

Slaughterhouse welfare indicators

Several important animal-based welfare indicators are scored at the slaughterhouse. Emaciated birds and birds with other diseases or lesions, will be rejected, being unfit for human consumption. Data on emaciation will provide information about prolonged hunger (Welfare Quality®, 2009). The slaughterhouse inspections will also provide good quality data on foot pad lesions and breast skin lesions. Although the direct causality of air quality parameters has not been scientifically established for respiratory diseases in turkeys, air sacculitis is undoubtedly causing significant discomfort of the animals and should therefore be regarded as a valid welfare indicator.

2 Hazard identification and characterisation

This chapter starts with a description of the literature search performed to identify and characterise hazards for welfare in turkeys that are relevant to the areas covered by the Terms of Reference from NFSA. Hazards identified are characterised within each area and sub-chapter. Exposure to relevant welfare hazards is also covered within the sub-chapters.

However, lack of available systematically collected health- and performance data from on-farm and slaughterhouse recordings in Norway (both from farmers, industry and NFSA), represents an important data gap with regards to exposure to welfare hazards in the Norwegian turkey population. Also, existing available data does not differentiate between turkeys slaughtered at 12 weeks and at 19 weeks.

2.1 Literature search

Web of Science was used to search for articles containing the keywords turkey AND welfare, turkey AND behaviour, and turkey AND stress. When other relevant references were found (e.g.,in article reference lists), these were included. Information from sources other than scientific literature were only included if considered scientifically viable by the VKM experts. See Chapter 1.3 for general remarks on the available scientific literature on turkey welfare.

A technical report on Animal welfare risk assessment guidelines on housing and management (EFSA Housing Risk) was prepared for EFSA on 27 August 2010 by Wageningen UR Livestock Research (Wageningen UR Livestock Research, 2010). The report lists all hazards during the production cycles of farm animals for decreased welfare (including turkeys for meat production) and their consequences. This is a thorough document, but since the ToRs cannot be answered by use of this report alone a new risk assessment has to be performed. The EFSA report is addressed when necessary.

2.2 Living area

2.2.1 Welfare hazards

The living area, equipment, and fixtures for turkeys shall, according to legislation, be designed to safeguard the animals' physical and mental needs, including behavioural needs, and to protect them from unnecessary stress, pain, and suffering (Regulation on keeping of poultry § 4, 7 and Regulation on production animals § 7).

Standard turkeys used for outdoor production are excellent flyers and cover large distances (Grimes et al., 2007). Wild turkeys roost in trees to sleep or avoid predators (Beranger et al., 2007b; Byrne and Chamberlain, 2013) and commercial turkey hybrids might therefore be assumed to feel safer when allowed to perch at night (Byrne and Chamberlain, 2013; Grimes et al., 2007). Commercial turkeys may only be able to perch during the earlier part of their lives, as they will become too heavy to jump and fly. Standard turkeys that are used for outdoor production start roosting at 2-5 weeks of age (Beranger et al., 2007a; Beranger et al., 2007b). Conventional female BUT6 turkeys will use elevated platforms for resting during the earlier parts of their life if they are provided, but use of such structures declines with increasing age (Spindler and Hartung, 2009). Commercial BUT9 turkeys of both sexes housed in 36 m^2 pens at a light intensity of 5 lux were observed weekly (Martrenchar et al., 2001). Perching was more common in females, peaked at week 5 (between 10 and 13 % of birds perched), and had declined to 0 % by week 10 (Martrenchar et al., 2001). Dedicated resting areas that are created using barriers could be alternatives to perches or raised platforms for older birds. This could be a possible alternative for creating areas of lower activity in order to reduce disturbance to resting birds. However, studies testing the efficacy of such barriers for commercial turkeys were not identified in the literature search. Large straw bales can be used simultaneously as raised platforms and stimulus for foraging activities. Although the turkeys accepted and used the enriching elements, there was no preventive effect on feather pecking (Letzguß and Bessei, 2009). There is literature that indicate that conventional turkeys (male BUT8) do not use the litter for dust bathing or ground scratching as laying hens do, even when housed at a low stocking densities (Sherwin and Kelland, 1998).

According to the EFSA report on housing risk of farm animals (Wageningen UR Livestock Research, 2010) different types of environmental enrichment did not have much effect on pecking behaviour. Turkeys pay attention to the playing objects just for a short time after installing. Attractiveness of the objects disappeared after some hours or days. Abrasive material in the feeders did not significantly affect injurious pecking.

The Regulation on poultry, § 18 (Norwegian Ministry of Agriculture and Food, 2001) states that «*sick and injured animals are to be kept separated from other animals when it is to their best. If prolonged life could be associated with unnecessary suffering of the animal, such as in the case of inability to walk properly, accumulation of abdominal fluid, and larger malformations, then treatment or culling should be performed immediately. When needed, a veterinarian should be called*». Recovery pens used for sick and injured animals may be considered as part of the living area for turkeys. Moving individual turkeys from the flock to small pens constitutes an animal welfare hazard because it requires extra attention and follow-up of the individuals (Arild Lysaker, pers. comm.).

2.2.2 Exposure to hazards

Commercial turkey production is done in a large, open room, on concrete floor with litter (usually wood shavings). During the production period the litter, which at first consists only of wood shavings, develops into a mixture of poultry excreta, spilled feed, feathers, and material used as initial bedding. There is also technical equipment providing water and food of various designs. Environment enrichments, with exception of the litter, which provide the birds with substrate for pecking, scratching and dust bathing, are usually not in use. Even if the use of available enrichment seem to vary through the production period, the environment must be considered as rather barren from the animals' point of view. There are obvious advantages with such an environment from a management and a hygienic point of view. The open room without hiding places makes it possible to have a good light distribution in the room, making it possible to inspect the environment and identify animals with health- or behavioural disturbances.

Perches, platforms or other environment enrichment are not very commonly used (Magne Hansen, pers. comm.). The opportunity to perch is limited. Many objects may be introduced in a turkey house to facilitate exploration, but the turkeys seem to lose interest very fast (Frackenpohl and Meyer, 2005).

There is currently no recording of data regarding use of recovery pens in Norwegian turkey operations, but concern has been raised from veterinarians that recovery pens may have the potential to prolong suffering to some individuals rather than alleviate suffering. With respect to handling, the knowledge and abilities of the responsible workers, as well as monitoring, are key for ensuring good animal welfare. Of particular importance is the ability to be able to recognise when a veterinarian should be consulted.

2.2.3 Summary

The effect of environmental enrichment on turkey welfare is uncertain, and more knowledge is needed. Use of recovery pens might represent a welfare hazard if appropriate routines for monitoring recovering turkeys are not followed.

2.3 Animal densities

2.3.1 Welfare hazards

For turkeys kept for meat production, animal densities shall not exceed 38 kg live weight/m^2 when the animals' average live weight is below 7 kg. When average live weight exceeds 7 kg, animal densities shall not exceed 44 kg/m^2 (Regulation on keeping of poultry, § 35d).

Maximum stocking densities are fixed in all national regulations and in volunteer animal welfare programmes for turkey. The value of regulating the stocking density is therefore considered to be of importance for the animal welfare by all stakeholders. The maximum standard requirements vary between the Nordic countries 58 kg/m^2 (Denmark), 44 kg/m^2 (Norway) and 30 kg/m^2 (Sweden). In Sweden, 45 kg/m^2 is accepted for members of an official control program and according to information from Sweden, the majority (about 97 %) of turkey farms are members of such programs (Magne Hansen, pers. comm.). These differences within the Nordic countries illustrate that experts disagree with the importance of this factor.

As for other poultry, turkeys need to be able to walk, jump, stretch, and flap their wings in order to maintain normal biological function. Walking, standing, and ground pecking are the main activities of commercial adult turkeys (Bessei, 1999). Other specific behaviours that turkeys express when provided with adequate space (Hughes and Grigor, 1996; Sherwin and Kelland, 1998) are briefly outlined in 1.5 Natural behaviour in turkeys.

Turkeys need the possibility of avoiding and escaping other aggressive birds (Buchwalder and Huber-Eicher, 2003; Buchwalder and Huber-Eicher, 2004; Buchwalder and Huber-Eicher, 2005). However, a critical distance of 50 cm appears to be enough to reduce the frequency of pecks to the head and neck of an unfamiliar male BUT9 turkey (Buchwalder and Huber-Eicher, 2004), suggesting that requirements regarding escape or avoidance distance should be fulfilled in any standard, loose-housing system. Practical experience with commercial poults shows that they very often actually stand still and do not escape when they are pecked by other birds (Magne Hansen, pers. comm.). Birds being prone to pecking are usually weak individuals lying down and should be culled or removed from the flock to prevent damage (Magne Hansen, pers.comm.).

Turkeys need to rest and sleep in order to maintain normal biological function. Open systems mean that the birds are susceptible to frequent disturbance by other birds. When the stocking density of BUT6 birds was increased from 2.5 to 3.5 birds (34-47 kg) per m^2 for males and from five to seven birds (27.5-38.5 kg) per m^2 for females, sitting and lying were reduced (Bessei and Günthner, 2005). Similarly, resting behaviour was increasingly disturbed in male and female BUT turkeys, that were housed according to sex, as density increased (for the males: 0.24 m^2 per bird (13.7 kg/m^2), 0.19 m^2 per bird (28.5 kg/m^2), and 0.15 m^2 per bird (36.7 kg/m^2) until week 12 and 0.40 m^2 per bird (33.8 kg/m^2), 0.31 m^2 per bird (43.5 kg/m^2) and 0.25 m^2 per bird (54 kg/m^2) from week 12; for the females: 0.16 m^2 per bird (34.4 kg/m^2), 0.12 m^2 per bird (45.8 kg/m^2), and 0.10 m^2 per bird (55 kg/m^2) (Martrenchar et al., 1999).

Martrenchar et al. (1999) suggested that stocking densities has minimal effects on behaviour, except for the frequency of disturbances of resting birds by other birds, which tended to be more frequent at the highest densities. In addition, gait deteriorated as stocking densities increased, hip and foot lesions were more frequent at the highest densities, and bodyweight decreased significantly with decreasing floor space. Bessei (2013) states that stocking densities has no direct effect of welfare-related behavioural and health criteria. However, stocking densities interacts with other factors, such as ventilation, ambient temperature, and litter quality. If these factors are not adequately adjusted in accordance with increasing animal densities, problems may arise.

2.3.2 Exposure to hazards

The maximum densities of turkeys in Norway is regulated by law (Norwegian Ministry of Agriculture and Food, 2001). During the final days of the production cycle, the density rises to 38 (hens) kg/m^2 or 44 (toms) kg/m^2 given in the Regulation on keeping of poultry and turkeys, and the lack of space for movement is decreased accordingly. Hence, the animals are not exposed to these densities for a very long time during their lifespan and are close to the limits only the last days before slaughter (Table 2.3.2-1).

Table 2.3.2-1 Densities during the lifespan of slaughter turkeys (approximate numbers)

	Kg (live weight) / m^2	
Week of production	**Hens**	**Toms**
1	1	1
4	9	10
8	18	24
12 (before slaughter of hens)	38	38
12 (after slaughter of hens)	-	23
14		30
18		40
19.5	-	44

2.3.3 Summary

Insufficient space for locomotion and body movement is a hazard for turkey welfare, and is of increasing relevance with progressing age and size of the animals. Restrictions on the possibility of avoiding or escaping other aggressive birds could pose a hazard to animal welfare during periods with higher densities. There does however not seem to be any increase in damages from aggressive birds (pecking) during these periods in Norwegian turkey production (Magne Hansen, pers. comm.). Also, if turkeys are unable to rest and sleep, this poses a hazard to their welfare by impairing biological function. Animal density and lack of resting spaces are both drivers for this hazard. Interactions with other factors, such as ventilation, ambient temperature, and litter quality may complicate the picture.

2.4 Air quality

2.4.1 Welfare hazards

According to legislation, ventilation, dust, noise, temperature, air humidity, and gas concentrations shall be kept at levels that are not harmful to the animals. The ventilation capacity for turkeys shall be at least 3.4 m^3 air exchange per kilo live weight per hour (Regulation on keeping of poultry, § 35d).

International recommendations for air quality (noxious gases, dust etc.) are based on several studies performed in different species of domestic animals, and few studies have been conducted specifically on turkeys.

Turkeys are warm-blooded (homoeothermic) i.e. their body temperature is quite constant. On average, the body temperature of birds is between 41°C and 42.2°C. Body temperature is regulated by a part of the brain. This part of the brain is comparable to a thermostat. Contraction and widening of blood vessels in the skin, lifting or retracting the plumage to regulate its air content, and the speed of respiration influence heat emission and retention, which consequently influence the body temperature. It takes some time before temperature regulating mechanisms start functioning in new-born animals and therefore they need a higher ambient temperature than adult animals do. Furthermore, the ratio between the surface area and weight of young animals is unfavourable and they do not have any fat reserves, thereby being more exposed to heat loss. See http://www.poultryhub.org/production/husbandry-management/housing-environment/climate-in-poultry-houses/

For turkeys the recommended ambient temperatures are 34°C – 30°C the first weeks decreasing to 16-17°C the days before slaughter (Hendrix Genetics, 2015). The consequence of low temperatures within acceptable range is increased feed intake, but will not necessarily have implications for animal welfare.

Ammonia concentrations (and other gaseous odours) are considered critical to bird welfare. Ammonia and other toxic gases need to be kept below certain levels for bird health and also to maintain good production. If excessive, they reflect inadequate ventilation or poor litter management. Ammonia levels greater than 50 ppm can reduce feed intake with effects on body weight and production, and levels of 20 ppm can cause lesions of the air sacs and inflammation of the cornea and conjunctiva (Carlile, 1984). Also, because stockpersons find high ammonia concentrations aversive, they do not want to be inside the stable and are likely to give birds only a cursory examination during routine inspections and this could delay diagnosis of health problems. While there is some argument over whether birds can smell ammonia, the evidence of adverse effects on birds exposed to ammonia would suggest they are at least as sensitive as people (Wathes, 1998). Surprisingly, Beker et al. (2004) found only limited effects of level of NH_3 up to 60 ppm on broiler chicken performance and health. Ammonia concentrations increase with wet litter. Patches of wet litter need to be removed from the shed and replaced with dry litter. Humans can smell ammonia at a level of 10 to 15 ppm; it irritates eyes and nasal mucous membranes at concentrations of 25 to 35 ppm. Thus, if there is an ammonia smell there is a potential air quality problem.

Hydrogen sulphide (H_2S) – H_2S is released when organic matter (protein) in the manure decomposes. Hydrogen sulphide is highly toxic to humans (and animals) with adverse clinical symptoms. Its main source is from the anaerobic decomposition of faeces/manure and this is more likely to occur if litter becomes wet and caked.

The carbon dioxide in poultry houses largely originates from air exhaled by the birds. The CO_2 content of the air is used to measure the effectiveness of ventilation. CO_2 cannot be detected by smell. At normal concentrations (0.3 % or 3,000 ppm) CO_2 is involved in the regulation of respiration. Thus, if CO_2 in the atmosphere increases, this results in an increased respiration rate which functions to minimize the increase in body CO_2.

Another noxious gas that is also odorless and colorless is carbon monoxide (CO). Carbon monoxide can bind with hemoglobin in the blood much more easily than oxygen (210 times faster) and this drastically reduces the amount of hemoglobin available to carry oxygen. Exposure to all these odors may affect the respiratory system leading to health problems for turkeys (Fallschissel et al., 2009).

In domestic poultry, there is a strong relationship between production and welfare (Al Homidan et al., 1998; Hayter and Besch, 1974; Kristensen et al., 2000). The immunological challenges often associated with poor air quality can lead to a reduction in feed intake and production (Kelley et al., 1987; Kemeny, 2000).

The dust in poultry houses mainly consists of skin particles, feathers, feed particles, litter and dried manure. These airborne particles could also increase the susceptibility of birds to diseases through irritant action or via allergic reactions (Harry, 1978). It is likely that improving air quality in turkey houses could improve production and provide a better working environment for stockpersons. Wathes (1998) indicated that the minimum ventilation rate required to provide acceptable levels of atmospheric dust should be 3.66 m^3/h/kg.

Martrenchar et al. (1999) state in a review that poor air quality in turkey houses is a direct consequence of high stocking densities, coupled with low ventilation rates in order to minimise heating costs. The recommended exposure has been calculated, not from experimental studies, but from field observations on the limits that induce health hazards. These limits are for ammonia (NH_3) 20 ppm, carbon dioxide (CO_2) 3000 ppm, carbon monoxide (CO) 10 ppm, dihydrogen sulphide (H_2S) 0.5 ppm, dust 3.4 mg/m^3, and for inhalable dust 1.7 mg/m^3. Requirements regarding air quality have been later reviewed by Glatz and Rodda (2013). Ammonia levels greater than 20 ppm are associated with lesions in air sacs, and inflammation of the cornea and conjunctivitis (Carlile, 1984). Hydrogen sulphide causes adverse clinical symptoms at concentrations above 10 ppm (Glatz and Rodda, 2013). Carbon monoxide concentrations should be below 50 ppm (Glatz and Rodda, 2013). When these concentrations are exceeded, it should be regarded as a hazard to turkey welfare.

Relative humidity should be kept between 50 and 70 %. Lower relative humidities will tend to result in a dusty house and high heating costs while higher relative humidities can lead to wet litter and high ammonia concentrations. See https://www.poultryventilation.com/sites/default/files/tips/2012/vol24n2.pdfhttps://www.poultryventilation.com/sites/default/files/tips/2012/vol24n2.pdf

According to an EFSA report on housing risk of farm animals (Wageningen UR Livestock Research, 2010) the hazards and their consequences related to the air quality may be summarised like this: Too high and too low temperatures causes heat/cold stress resulting in malnutrition and mortality. Poor ventilation and poor air quality with high levels of noxious gases causes respiratory diseases, eye problems, wet litter resulting in skin lesions.

2.4.2 Exposure to hazards

The Norwegian Regulations do not set minimum requirements for these parameters, with the exception of the air exchange. The KSL standard for turkey meat production in Norway requires that the levels of ammonia should not exceed 25 ppm and the level of carbon dioxide should not exceed 3000 ppm (Matmerk, 2015). Unfortunately, data on actual levels on noxious gases and dust in Norwegian turkey farms are not systematically collected.

Air sacculitis is an obvious problem based on the information from NFSA, insurance companies and the industry, and it is not an unusual finding on carcasses presented for meat inspection, even if the frequency varies between age groups, time of the year, farms and slaughterhouses (Norwegian Food Safety Authority, 2015). This may indicate that levels of ammonia or dust can reach harmful levels in some production units. According to information from NFSA, condemnations due to air sacculitis were about 0.9 % during 2015. Gjensidige Insurance (Torfinn Jæger, pers.comm.) reports that losses caused by air sacculitis is the major cause of insurance claim by Norwegian farmers. NFSA reports show that air sacculitis was a major cause of total condemnations on the abattoirs in Østfold county during 2013 (1.1 %), 2014 (1.6 %) and 2015 (0.9 %) (Hani Matheus Daryous, pers. comm.). Since the total condemnations only reflect the most severe affections, the numbers of carcasses with local condemnations caused by/due to air sacculitis must also be taken into consideration (Hani Matheus Daryous, pers. comm.).

The project group observes that Wathes (1998) recommends a higher air exchange than the Norwegian regulations, but the value of this is uncertain.

2.4.3 Summary

Low and high temperature and high levels of dust, ammonia and other noxious gases are potential hazards for turkey welfare. The connections between different air quality parameters and air sacculitis and respiratory diseases are not known.

2.5 Bedding

2.5.1 Welfare hazards

The bedding shall be kept sufficiently dry, and when new animals are introduced to the building, new bedding material of suitable quality and quantity shall be provided to stimulate the animals to peck, kick, and dust bathe (Regulation on keeping of poultry § 20).

Inappropriate diet and inadequate health management causes higher water intake, diarrhoea and thereby wet litter. Gut infections (coccidiosis and necrotic enteritis) are common in turkeys. Data from Animalia (Thorbjørn Refsum, pers. comm.) indicate that 22 of 159 turkey flocks (13.8 %) were treated with therapeutic antibiotics during 2014. In 2015, only nine of 187 flocks (4.9 %) were treated. Most of these cases were associated with clinical necrotic enteritis caused by toxins of *Clostridium perfringens*, and this is currently the most common infectious gut disease in Norwegian turkeys. Such cases are usually treated with phenoxymetylpenicillin, but amoxicillin is also used with satisfactory results. Coccidiosis (a parasitic disease) is controlled with coccidiostats (usually monensin) in the feed until five days before slaughter and clinical coccidiosis is presently rare (VKM, 2015). Other infectious gut diseases are controlled by use of strict hygienic measures, including an all in-all out system, and thorough cleaning and disinfection between the flocks. Other diseases are rare.

Turkeys require flooring to be of a material that does not cause harm to the birds. Turkeys may be housed on slatted floors, which enables them to be separated from their faecal droppings, or on litter/bedding that absorbs and stores the moisture from defecation, spillage, etc. Wojcik et al. (2004) recommended that turkeys were not kept on a slatted floor. Turkey toms kept on slatted floors made of metal mesh had lower final bodyweights, higher losses in bodyweight during transportation, and greater numbers of birds with damaged carcasses in comparison with turkey toms kept on litter flooring. Therefore, it appears that turkeys thrive better with litter in their living area. There is literature that indicate that conventional turkeys (male BUT8) do not use litter for dust bathing or ground scratching as laying hens do, even when housed at a low stocking densities (Sherwin and Kelland, 1998). Poultry litter or broiler litter used in agriculture is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding in poultry operations. This term is also used to refer to unused bedding materials. Common bedding materials that are used internationally include wood shavings, sawdust, peanut hulls, shredded sugar cane, straw, and other dry, absorbent, low-cost organic materials. Turkeys in Norway are usually reared on pine or fir wood shavings that are readily purchased from the wood industry.

It has been shown that foot pad lesions start to develop during the early days of life if the birds are exposed to wet litter (Krautwald-Junghanns et al., 2013). Wet litter (Clark et al., 2002; Mayne, 2005; Mayne et al., 2007; Shepherd and Fairchild, 2010; Youssef et al., 2011) and high stocking densities, (Clark et al., 2002) coupled with poorly functioning fan ventilation systems (Martrenchar et al., 2002) are risk factors for foot pad dermatitis (FPD; hard and scaly foot pads with hornlike keratin pegs, swelling, and necrotic lesions) and pododermatitis (inflammation of the feet) (Clark et al., 2002). (Youssef et al., 2011) conclude that the prevalence and severity of FPD can be reduced by maintaining dry litter.

Breast skin lesions (breast buttons) have a complicated pathogenesis (Mitterer-Istyagin et al., 2011), but are often a result of too high litter moisture. Mitterer-Istyagin et al. (2011) concluded that aspects of animal welfare as well as food production, hygienic, and economic issues require a reduction of the high prevalence of breast skin alterations. They meant also that the prevalence of pododermatitis and breast skin alterations are suitable indicators for a retrospective evaluation of the bird rearing methods on turkey farms.

During early production phases, litter should be even to reduce the likelihood of poult flipover. Poult flipover caused by uneven bedding surface may cause mortality (Hendrix

Genetics, 2015). Poults that have flipped should be placed in the recovery area to prevent dehydration (Hendrix Genetics, 2015).

According to the EFSA report on housing risk of farm animals (Wageningen UR Livestock Research, 2010) the hazards and their consequences related to the bedding may be summarised like this: Leakage from drinkers results in wet litter causing skin lesions. Poor ventilation and heating cause too high humidity of the litter.

2.5.2 Exposure to hazards

There are no scientific studies available that describe the litter quality in Norwegian turkey houses. Two local control projects performed by NFSA on FPD have been performed (Norwegian Food Safety Authority, 2015; Norwegian Food Safety Authority, 2015). Both studies conclude that FPD is a major challenge in Norwegian turkey production. There is no information available on the quality of the actual litter quality in Norwegian turkey herds, but the high incidence of FPD indicates that wet litter is common.

2.5.3 Summary

Foot pad dermatitis (lesions) and other skin lesions are consequences of wet bedding and seem to be widespread in turkey production. Wet bedding is therefore considered a major hazard for turkey welfare.

2.6 Feeding and watering

2.6.1 Welfare hazards

The amount of feed and the feeding shall be adequate and comprised so as to fulfil the animals' needs in all circumstances. The feed shall ensure satiation (Regulation on keeping of poultry § 16).

Turkeys need feed that is formulated according to their nutritional requirements and detailed recommendations can be found in turkey production manuals (Aviagen, 2015; Hendrix Genetics, 2013; Hendrix Genetics, 2015). Turkeys may also need grit. Grit stimulates gizzard development, helps birds break down litter that they have eaten, and slows the rate of passage through the gastrointestinal tract, which may increase nutrient absorption in cases of enteritis (Hendrix Genetics, 2015).

Turkeys need fresh clean water to drink. Water pressure in the supply line should be high enough to ensure even flow, but low enough to prevent dripping and wet litter. Water nipple cups should be even with the poults' head. Drinker lines (water pipes with drinking nipples that passes in a longitudinal direction through the house) should be adjusted high enough that birds can pass underneath without lowering their heads (Hendrix Genetics, 2015). Birds suffering from dehydration may behave listlessly, have a sunken appearance in the crop area, and have white crystals around the vent (Larson et al., 2007).

Because of the highly automated feeding and drinking systems in poultry houses, poultry are exposed to a hazard in connection with a breakdown of these systems. Proper surveillance and management is needed to ensure that these systems function as planned (Matmerk, 2015).

Another hazard for turkeys in connection to their feed, is represented by remains of the coccidiostat narasin in the feed. Turkeys are highly sensitive to narasin intoxication and remains of narasin-containing broiler feed might have serious consequences for the animals. Broiler feed with < 70 mg/kg (normal content of narasin in broiler feed) is toxic for turkeys (Markiewicz et al., 2014).

According to the EFSA report on housing risk of farm animals (Wageningen UR Livestock Research, 2010) the hazards and their consequences related to the feeding and watering may be summarised like this: Inappropriate diet causes malnutrition that may lead to behaviour disturbances, bone weakness and decreased immune status that can result in diseases.

2.6.2 Exposure to hazards

The Regulation on poultry (Norwegian Ministry of Agriculture and Food, 2001) and the requirements from the industry on this concern are not very specific, but there are no reports available from the industry or the NFSA that indicate that these regulations are not followed. In the present assessment, the authors assume that the water given to the animals is of drinking quality, regulated by the Regulation on water supply and drinking-water (Norwegian Ministry of Health and Care Services, 2001), and that the feed is normally bought from quality assured commercial companies (Felleskjøpet, Norgesfôr, Fiskaa Mølle) that use feeding guidelines from the hybrid firms (e.g., Aviagen, Hendrix Genetics) when they optimise their feed.

Intoxications and malnutrition caused by failures in the feed mills might occur, but no claims regarding turkey feed have been submitted to the Norwegian Complaints Committee for Grain and Fish feed (Reklamasjonsnemda for kraftfôr og fiskefôr) for the last six years (Kåre Bjørlo, pers.comm.).

2.6.3 Summary

Insufficient diet, inappropriate quality of drinking water and failures of the feeding- and drinking system are potential hazards for turkey welfare. However, the probability of turkeys being exposed to these potential hazards related to feeding and drinking is low.

2.7 Lighting regime

2.7.1 Welfare hazards

According to regulations, the living area for poultry shall be sufficient lit for the animals to be able to perform normal activities and to see each other clearly. Periodic dimming, or dimming of light in partial areas, is allowed when suitable to reduce occurrence of health defects or behavioural problems. The lighting regime shall, after the first few days of adaptation, follow a 24-hour light/dark cycle and contain an uninterrupted dark period of at least 8 hours (Regulation on keeping of poultry § 12). *Aviagen recommends brightness of between 10-20 lux, and the industry claims that turkeys need a minimum of 5 lux to see each other clearly.*

Turkeys see light in the UV range (Hart et al., 1999) and it has been claimed that light in this range facilitates individual recognition. Indeed, the provision of ultraviolet light reduced the incidence of tail and wing injuries in male BUT6 turkeys up to 5 weeks of age housed at 10 lux (Moinard et al., 2001). Studies described below have indicated that turkeys prefer higher light levels (5 - 200 lux) during active periods and lower light levels for sleeping. At 2 weeks of age, BUT6 turkey poults prefer 200 lux (Barber et al., 2004) both for active periods and sleeping. At 6 weeks of age they prefer illuminances > 6 lux for inactive resting and perching behaviours (Barber et al., 2004) but > 20 lux for active periods Male BUT8 turkeys (6-19 weeks of age) preferred to occupy areas with 5, 10 and 25 Lux, but did not voluntarily enter areas of <1 Lux (Sherwin, 1998). Light flux below 5 lux is probably insufficient to pass through the skulls and cranial tissues to the pineal glands of laying hens, where it would normally suppress the production and release of serotonin and melatonin (Zawilska et al., 2004). Therefore, similarly to laying hens (Janczak and Riber, 2015), turkeys are likely to need a minimum of illumination of 5 lux to ensure serotonin and melatonin production is appropriately suppressed. At very low illuminance levels, exploratory behaviour may be difficult to perform (Martrenchar, 1999).

Barber et al. (2004) reported that two week-old turkey poults showed an overall preference for 200 lux and for illuminances >20 lux at six weeks. At the same time farmers report that injurious pecking and aggression occur at levels > 1 lux. These results imply that preferred illuminances for the animals are associated with injurious pecking and aggression under practical conditions.

In a review by Bessei (2013), lighting programmes that provide a distinct night-day rhythm are recommended, as continuous lighting is associated with lethargy and a lack of day-night rhythm in the turkeys. Bessei (2013) also states that recommendations on minimum light intensity as lux are not justified with regards to the bird’s welfare, and that there is a lack of scientifically sound data on the optimal illuminance.

Illuminance may affect various aspects of welfare in broiler chickens, laying hens, and turkeys. Poultry may develop eye abnormalities if reared in dim and/or continuous lighting

(Sherwin, 1998). There is conflicting evidence for the effects of light intensity on feather pecking; some studies have found increased feather pecking in high light intensity, although others have found no effects of light intensity. This discrepancy may be due to confounding different aspects of the light environment. Birds appear to show reduced fear of humans in 5 lux, but it is uncertain whether this is due to the light intensity *per se* or to relative changes in light intensity. Layers, broilers, and turkeys prefer brightly lit environments (200 lux) at two weeks of age, whereas at six weeks old layers and broilers prefer dimmer light environments (6 lux). Turkeys maintain their preference for brighter environments (20-200 lux) and avoid entering environments lit by <1 lux. The findings on the effects of illuminance on poultry welfare, requires commercial-scale validations before firm conclusions can be drawn (VKM, 2008).

According to the EFSA report on housing risk of farm animals (Wageningen UR Livestock Research, 2010) the hazards and their consequences related to the light regime may be summarised like this: Inappropriate light intensity (incl. natural lighting) result in feather pecking and cannibalism. Inappropriate light cycle results in locomotion disorders.

2.7.2 Exposure to hazards

The recommendations for lightning in turkey houses are summarised in a fact sheet from Animalia (http://www.animalia.no/upload/FIler%20til%20nedlasting/HT-Fj%C3%B8rfe/lys%20til%20kalkun.pdf). These recommendations refer to Aviagen with regard to illuminance (10-20 lux during the light periods) and to the Regulation of keeping poultry which requires a period of darkness of 8 hours. In the animal welfare plan for the Norwegian poultry industry, a level of 5-10 lux during the light periods of the production is stated as an important aim.

To prevent outbreaks of injurious pecking the illuminance is usually dimmed to 5-7 lux. Some producers use lower intensities (about 1 lux).

Reports from audits from the NFSA or the KSL are not available, but there is reason to believe that light is dimmed to lower levels than 5 lux by some farmers, in accordance with Regulation on keeping of poultry § 12, in order to reduce the likelihood of feather pecking and cannibalism.

The insurance company Gjensidige (Torfinn Jæger, pers.comm.) has reported of that smothering (clumping) during the period with total darkness and the following suffocation of animals has been the reason for several claims the last ten years. The project group has not found any scientific papers that refers to this condition, but it seems to be a problem in some farms. This may be an argument for using some light (e.g. 1 lux) during the darkness period.

2.7.3 Summary

Too high and too low light intensity in addition to inappropriate light cycle are hazards for turkey welfare.

2.8 Artificial insemination

2.8.1 Welfare hazards

Parent stock is regularly inseminated artificially. According to the Regulation on production animals (§ 12), breeding, including the use of natural or artificial breeding methods, shall not be carried out if it results, or may result, in suffering or wounds. This regulation does not, however, prohibit use of certain methods that might inflict minimal or brief suffering or wounds.

The feed deprivation may be imposed six hours prior to semen collection/artificial insemination (SC/AI) prevents contamination, but may inflict stress. It may also result in birds damaging each other when fighting for feed when birds are given access to feed following a period of deprivation. Removal of hens from the flock to prevent them from becoming broody and ceasing to lay eggs deprives them of a behavioural need and may cause stress.

Herding and catching birds to perform the SC/AI procedures may cause physical damage and/or stress to birds if not performed sufficiently carefully and with focus on ensuring the welfare of the birds. With a large number of birds to be inseminated, a steady flow of birds to the pit where the AI is performed is necessary. Piling and/or struggling of the animals, may result in scratches or wounds inflicted from other birds, the equipment, or the drivers. Plumage may be damaged and the birds may experience varying degrees of stress. The weight of the animals and the design of the pit or semen collection site may also necessitate dragging the animals (for a short distance). Depending on the properties of the surface of the floor, this may cause wear and tear of plumage. The weight and struggling of the birds may also impose damage to the birds' legs or wings if caught incorrectly, for example by one leg or one wing. If a mechanical clamp is used for fixation, pain and/or damage may result from the birds struggling or from malfunction of the clamp.

The procedure of SC is associated with friction of the cloaca. The gross appearance of the turkey cloaca was examined before and after single and multiple semen collections (Bakst and Cecil, 1983). They reported that all cloacae exhibited some degree of haemorrhage formation, the extent of which was dependent upon the frequency of SC, the number of cloacal strokes, and individual differences between semen collectors' techniques. Cloacae examined three days after the last SC were normal in appearance.

During AI of hens, discomfort and physical damage/haemorrhage formation in the vagina may result from inserting the straw using too much force.

Both opportunistic and obligate pathogens, such as *E. coli*, *Pasteurella*, *Mycoplasma,* and *Erysipleothrix* (Cariou et al., 2013; Dhama et al., 2014; Parkhurst and Mountney, 1988), might be transmitted by AI, and this procedure might thus represent a hazard for health and welfare in hens.

2.8.2 Exposure to hazards

Feed restriction for six hours before SC/AI is probably not an animal welfare hazard in the relatively small Norwegian breeding operations. However, it is essential that the regulations regarding feeding systems are followed, and behaviour is monitored during subsequent feeding.

Stress and damage as a result of handling, catching, fixation, and SC/AI procedures impose a hazard to welfare. The extensive and frequent handling of breeding turkeys makes them particularly vulnerable. The turkey breeder flocks in Norway are small compared with the sizes in other countries. Workers performing AI in Norway inseminate between 300-1,500 hens a day, compared with up to 6,000 a day in some countries (http://www.upc-online.org/fall94/breeding.html 18.5.2015). This means the workload in Norway should be relatively low and thus the possible stress to the workers that might otherwise have resulted in rough handling and reduced welfare of the turkeys, should be tolerable. On the other hand, smaller operations may be at a disadvantage due to there being fewer workers who are available to perform some procedures.

Regardless of the size of the operation, the knowledge and attitude of the SC/AI personnel is key to ensuring good animal welfare during the procedures. No formal requirements for education/training of SC/AI are required for the personnel, and courses for learning about this kind of procedure are not available in Norway. Selecting, educating, training, and monitoring the personnel involved in carrying out these procedures are solely the responsibility of each breeding operation, and may thus vary widely between the operations.

One source of animal welfare indicators for turkey breeding hens is data from the meat inspection at slaughter. These data show that conditions leading to total or partial rejection are rare. Examples from one Norwegian slaughterhouse: Salpingitis 1 % (2013), 2 % (2014); skin-related conditions: 0.05 % (2013), 0.2 % (2014). As comparative data from natural copulations are lacking, data from broiler chicken breeder hens may be used (with caution). Comparing broiler chicken breeder hens and turkey hens at the slaughterhouse shows that the prevalence of salpingitis in turkeys is comparable or higher (0.5% in broiler chicken breeders in 2014), the prevalence of breast blisters in turkeys is higher, whereas the prevalence of skin-related damages (infections, wounds) in turkeys seem to be much lower than in broiler chicken breeders (4.5% in broiler breeders 2014) (Hani Matheus Daryous, pers. comm.). Skin related damages in broiler chicken breeders are often presented with claw scratches on the back, whereas turkeys have more generalized wounds and in particular from pecking (Hani Matheus Daryous, pers. comm.).

2.8.3 Summary

Herding and catching of the animals prior to SC/AI, handling and technical procedure in connection with SC/AI and the feed deprivation prior to insemination are hazards for turkey welfare.

3 Risk characterisation

The risk of reduced welfare is defined as probability that a hazard will occur, multiplied by the consequence of that hazard.

Turkey production is standardized throughout Norway and many hazards for reduced welfare and the consequences are the same in all farms. However, probabilities of some hazards may be reduced by appropriate management and individual worker skills and knowledge, and the risks for such hazards will therefore vary between farms.

In this assessment, the project group has chosen a three-grade scale concerning probabilities and consequences. Numbers are estimated.

- Low probability: <1 % turkeys will experience the given hazard
- Moderate probability: 1 – 10 % of turkeys will experience the given hazard
- High probability: >10 % of turkeys will experience the given hazard

- Limited consequence: No or limited consequence for animal welfare
- Moderate consequence: Moderate consequence for animal welfare
- Serious consequence: Serious consequence for animal welfare

Risk is defined as the probability of the occurrence of a given hazard multiplied by the physical and/or mental consequence of this hazard. In the following risk charts of this chapter, different levels of risk are symbolised as follows:

- Low risk: Green
- Moderate risk: Yellow
- High risk: Red

3.1 Living area and related welfare risks

Probability and consequence of welfare hazards for turkeys kept for meat production related to living area were assessed by the VKM Panel on animal health and welfare. The resulting risk characterisation is shown in Figure 3.1-1.

The effect of environmental enrichment on turkey welfare is uncertain, and more knowledge is needed for risk characterisation. Use of recovery pens might represent a welfare hazard, and is considered a moderate welfare risk, if appropriate routines for monitoring recovering turkeys are not followed.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA Incorrect use of recovery pens	cB	cC
	Moderate (b)	bA	bB	bC
	Limited (a)	aA	aB	aC

Figure 3.1-1 Living area and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

3.2 Animal densities and related welfare risks

The effect of animal density on animal welfare is uncertain, and more knowledge is needed for risk characterisation. However, insufficient space for locomotion, body movement, resting/sleeping and escaping aggressive birds should be considered a hazard for turkey welfare, and is of increasing relevance with progressing age and size of the animals.

3.3 Air quality and related welfare risks

Probability and consequence of welfare hazards for turkeys kept for meat production related to air quality were assessed by the VKM Panel on animal health and welfare. The resulting risk characterization is shown in Figure 3.3-1.

Low and high temperature and high levels of dust, ammonia and other noxious gases are potential hazards for turkey welfare. Low temperature would have serious consequences on turkey welfare, but the probability of this hazard is considered low. Risk characterisation of dust, ammonia and other noxious gases was not possible to perform, due to lack of data.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA Low temperature for poults	cB	cC
	Moderate (b)	bA High temperature	bB	bC
	Limited (a)	aA	aB	aC

Figure 3.3-1 Air temperature and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

3.4 Bedding and related welfare risks

Probability and consequence of welfare hazards for turkeys kept for meat production related to bedding were assessed by the VKM Panel on animal health and welfare. The resulting risk characterization is shown in Figure 3.4-1.

Foot pad dermatitis (lesions) and other skin lesions as are consequences of wet bedding, and seem to be widespread in turkey production. Wet bedding is therefore considered a major hazard for turkey welfare.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA	cB	cC Wet bedding
	Moderate (b)	bA	bB	bC
	Limited (a)	aA	aB	aC

Figure 3.4-1 Bedding and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

3.5 Feeding and watering and related welfare risks

Probability and consequence of welfare hazards for turkeys kept for meat production related to feeding and watering were assessed by the VKM Panel on animal health and welfare. The resulting risk characterization is shown in Figure 3.5-1.

Insufficient diet, inappropriate quality of drinking water and failures of the feeding- and drinking system are potential hazards for turkey welfare. However, the probability of turkeys being exposed to these potential hazards related to feeding and drinking is low. Failure of the feeding system is considered to be a low risk to animal welfare, whereas there is a moderate risk for turkey welfare in connection to inappropriate diet, quality of drinking water, as well as failure of the drinking system.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA Inappropriate diet Inappropriate quality of the drinking water Failure of the drinking system	cB	cC
	Moderate (b)	bA Failure of the feeding system	bB	bC
	Limited (a)	aA	aB	aC

Figure 3.5-1 Feeding and watering and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

3.6 Lighting regime and related welfare risks

Probability and consequence of welfare hazards for turkeys kept for meat production related to lighting regime were assessed by the VKM Panel on animal health and welfare. The resulting risk characterization is shown in Figure 3.6-1.

Too high and too low light intensity in addition to inappropriate light cycle are hazards for turkey welfare, representing moderate welfare risks.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA High light intensity Inappropriate light cycle	cB	cC
	Moderate (b)	bA	bB Low light intensity	bC
	Limited (a)	aA	aB	aC

Figure 3.6-1 Lighting regime and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

3.7 Semen collection/artificial insemination procedures and related welfare risks

Probability and consequence of welfare hazards for turkey parent stock related to semen collection and artificial insemination were assessed by the VKM Panel on animal health and welfare. The resulting risk characterization is shown in Figure 3.7-1.

Herding and catching of the animals prior to SC/AI, handling and technical procedure in connection with SC/AI and the feed deprivation prior to insemination are hazards for turkey welfare. The AI procedure and feed deprivation prior to insemination are considered moderate risks to turkey welfare, whereas the SC procedure, herding/catching and handling are considered to be a low risk to turkey welfare.

		Probability		
		Low (A)	**Moderate (B)**	**High (C)**
Consequence	**Serious (c)**	cA Damage/haemorrhage formation during AI procedure	cB	cC
	Moderate (b)	bA Haemorrhage formation during SC procedure	bB	bC
	Limited (a)	aA	aB Stress or injuries caused by handling Stress or injuries caused by herding and catching	aC Feed deprivation prior to AI

Figure 3.7-1 Artificial insemination/semen collection procedures and related welfare risks. Green areas (aA, aB, bA) symbolise low welfare risk, yellow areas (cA, cB, aC) moderate welfare risks, and red areas (cB, cC, bC) high risks for turkey welfare.

4 Risk-reduction measures

Risk-reduction measures were requested by NFSA in the Terms of Reference with regards to living area, bedding, and feeding. For stocking densities, air quality, and lighting, specific numbers on appropriate levels were requested. With the exception of recommended levels for stocking density, these are given in Chapter 6, Answers to the Terms of Reference, and are not discussed in Chapter 4. In general, the best initial risk reduction measure is to be certain of that the farmers follow the requirements given in the public regulations and the guidelines for poultry production given by the industry (Matmerk, 2015). Both regulations and guidelines should be revised according to the risk reduction measures recommended in this report. Compliance should be revised regularly by the farmer, by external assessors or by inspectors from the NFSA.

An action plan with regard to animal health and welfare for poultry 2014-2017 has been launched by the industry (Animalia, 2014). A proper risk reduction measure will be to encourage farmers and industry to follow up the good practices that are presented in this plan.

4.1 Living area and reduction of related welfare risks

Mandatory and detailed routines for inspection, assessment, and treatment are important to ensure that the animals do not suffer in the living area, including recovery pens. Management guidelines for the use of recovery pens should be available. It is important to register the following data: date in, diagnosis/reason, status/description of condition, daily update on status, water intake and feed intake and treatment. There should be a low threshold for consulting a veterinarian. Recovery pens should contain the same system for feeding and drinking as the animals are accustomed to in their regular living environments and generally be built in accordance with the animal's needs.

4.2 Bedding and reduction of related welfare risks

Litter with too high humidity is a welfare hazard at all stages of the production because of the risk of FPD and other skin lesions associated with contact with wet litter. Therefore, proper litter management is the key to improved turkey welfare. 20 – 30 % humidity of the litter is considered as a good level (see below).

Water pipes and drinkers should be thoroughly cleaned between flocks and be free of particles and biofilms that could create leakages and "cake formations" in the litter below the drinkers. If nipples are used instead of drinkers, bowls should be placed under each nipple to prevent leakage to the litter. Bedding should be as cake free as possible (Hendrix Genetics, 2015) and should be maintained at appropriate humidity levels. 20 – 30 % humidity of the litter is considered as a good level (http://www.thepoultrysite.com/articles/2704/managinglitter-moisture-in-broiler-houses-with-builtup-litter/). Additional bedding or tilling may be necessary. Proper ventilation, heating and water management helps to ensure good litter quality. When water spills occur, the wet litter must be removed and replaced (Hendrix Genetics, 2015).

Appropriate gut health control and preventing diarrhoea to reduce water intake and wet droppings is of importance. This is done by ensuring high levels of biosecurity with hygienic measures (proper cleaning and disinfection between flocks). Correct use of coccidiostats or other preventive measures such as prebiotics and probiotics (VKM, 2015) to control coccidia and other pathogen microflora is of importance. Clinical disease e.g. necrotic enteritis (NE) caused by *Clostridium perfringens* has to be treated immediately.

Skin lesions and air sacculitis are more frequent in older toms for industry purposes (Hani Matheus Daryous, pers. comm.), and a relevant risk reduction measure in units with a high frequency of skin lesions will be to shorten the production period.

4.3 Feeding and watering and reduction of related welfare risks

To reduce the risk of impaired welfare related to feed, feeding, water and watering, the farmer should follow the guidelines from the industry (Matmerk, 2015). That means e.g. that always water from a water source of drinking water quality is to be used. Sampling for analysis at an approved laboratory should be taken regularly and at least once a year. The water pipes, the drinkers and the feeding system should be thoroughly cleaned and controlled between each flock. Only feed composed in a way that satisfies all nutritional needs at any age of the specific hybrid is to be used.

4.4 Artificial insemination and reduction of related welfare risks

Knowledge, experience and attitude towards animal welfare and animal handling are very important in semen collection and AI. A compulsory education/training program may be advantageous. As both semen collection and AI are procedures, which require good practical skills to perform successfully, maintaining good animal welfare, a training course should include practical training.

Veterinary visits on a regular basis to assess health and animal welfare in the breeder flock, with review of relevant documentation and animal welfare assessment of handling, semen collection and AI procedures could be beneficiary for animal welfare. Turkey breeding toms are not slaughtered in abattoirs at present (euthanized on farm) because of their large size (only about 100 animals/flock). No data from the meat inspection or from veterinary inspections on farm performed by the competent authorities are available.

More detailed specifications on health welfare and production parameters that have to be recorded on a daily basis would be helpful in auditing health and welfare situation in the breeding flocks. That would also be a valuable tool for the veterinarian working with the breeding operation.

Guidelines or requirements to equipment important to animal welfare would be useful. Such equipment includes herding equipment, surfaces in/at pit for insemination, and equipment for fixation.

To have minimum requirements regarding care and handling procedures and resources for broody hens would seem to be advantageous for providing animal welfare to this group of animals. Regulations from the authorities or guidelines from the industry itself would be useful.

5 Uncertainties

Most of the conclusions that have been drawn regarding the risk of poor welfare associated with turkey behavioural needs, and also many of the conclusions reached regarding turkey physiological needs, are based on a rather limited available volume of scientific literature. The exception is for obvious physiological needs in animals, such as the needs for feed, water, sleep, and the possibility of movement.

Studies in turkeys are often performed with specific hybrids, and although the various turkey hybrids are very similar, caution must be exercised in extrapolating the findings in one hybrid directly to other hybrids. Furthermore, studies may be performed at different light conditions and housing types, and therefore not be valid for Norwegian conditions.

6 Answers to the terms of reference

ToR 1 Physiological and behavioural needs

What are the physiological and behavioural needs of farmed turkeys (*Meleagris gallopavo*)?

The physiological and behavioural needs of farmed turkeys are described in detail in Chapter 1.5., but are summarised below:

- Turkeys need clean water to drink.
- Turkeys need feed that has been formulated according to their nutritional requirements.
- Turkeys need fresh air of appropriate humidity and without harmful levels of noxious gases and dust.
- Turkeys need an environment with a temperature range that allows them to regulate their body core temperature. This must be combined with an appropriate relative humidity.
- Turkeys need to see. Turkeys see light in the UV range and it has been claimed that light in this range facilitates individual recognition. Turkeys, as laying hens, are likely to need a minimum illumination of 5 Lux in order to see functionally, but show a preference for higher light intensities during the light cycle. It is uncertain whether turkeys need complete darkness in order to sleep.
- Turkeys need to rest and sleep in order to maintain normal biological function. Wild turkeys roost in trees to sleep or avoid predators and can be assumed to feel safer (see previous point) when allowed to perch at night.
- Turkeys need to use their muscles for walking, standing, and ground pecking.
- Turkeys need to peck in order to eat and may need to peck in connection with exploration of the environment.
- Turkeys need to preen to keep their plumage in shape.
- Turkeys need the possibility of avoiding and escaping other aggressive birds.
- Turkeys may need litter to scratch and dust bathe.
- Turkeys may need to sit on their eggs to brood.
- Turkeys may need grit in a similar manner to chickens (no studies addressing this requirement in turkeys are available).

ToR 2 Living area, equipment, and fixtures

a. **What is the risk that the animals' physiological and mental needs are not fulfilled?**

In this assessment we have addressed hazards that might pose a moderate to high risk for reduced animal welfare: Not enough space to fulfil basic needs for movement and avoidance; insufficient space for rest and sleep during the last days of production; lack of elevated platforms; lack of perches; barren environment without enrichment; incorrect use of recovery pens. However, only the use of recovery pens was subject to risk characterisation, as data on effect on animal welfare was lacking with regards to elevated platforms, perches and other environmental stimuli.

Use of recovery pens is considered a moderate welfare risk, if appropriate routines for monitoring recovering turkeys are not followed.

b. What is the risk that the animals are subjected to stress, pain, suffering, or other strains resulting in reduced welfare?

As mentioned under 2a, the turkeys might be unable to fulfil basic needs for movement and aviodance, and might not have space for rest and sleep during the last days of production. This might cause some stress and thus represent potential hazards for animal welfare. However, it is not possible to perform a complete risk assessment due to a lack of knowledge. The risk of suffering because of a barren environment, including the lack of fulfilment of the need for perching in young individuals, is not possible to characterise, due to lack of data. However, these are identified as potential hazards in this risk assessment. Use of recovery pens represents a moderate welfare risk if appropriate routines for monitoring recovering turkeys are not followed.

c. What measures for risk reduction could be applied?

The effect of environmental enrichment on turkey welfare is uncertain, and more knowledge is needed for risk characterisation. Perches may be provided for young animals, but they tend not to be used by older and heavier animals. Elevated platforms may be used to a greater extent and straw bales could be used both as elevated platforms and as objects for straw pecking. Researchers have also suggested using barriers that provide resting areas in which there is less traffic compared with areas without barriers.

Overcoming space limitations for enrichments, movement, resting and sleeping, and possibilities for escaping aggressive birds can only be achieved by increasing the available area. This means that animal densities would need to be reduced accordingly.

ToR 3 Animal densities

a. What is the risk that today's requirements on stocking densities compromise animal welfare?

Stocking densities interact with other factors, such as ventilation, ambient temperature, and litter quality, and if these factors are not adequately adjusted in accordance with increasing animal densities, animal welfare may be compromised (see also ToR 2). High stocking densities during the last days of the growing period may further influence on ease of movement, ability to avoid aggressive conspecifics, and undisturbed rest (see ToR 2). However, data on this subject are scarce.

b. What level of stocking densities would fulfil the animal's physical and mental needs?

A specific level of stocking density for which all the physiological and mental needs of turkeys are fulfilled is not provided in the literature. As previously mentioned, stocking densities interact with other environmental factors, e.g. litter and air quality. Lower stocking densities during the last days of production will probably make it easier for the farmer to control these factors, and thus it is less likely that animal welfare is compromised than at higher densities. Lower densities during the final days of production would provide the animals with more room for movement, as well as possibilities for rest (see ToR 2).

ToR 4 Air quality

a. What is the risk for reduced welfare when adhering to today's requirements for ventilation capacity?

In order to keep within the recommended values for air quality, management of the ventilation system is crucial. As foot pad dermatitis and skin lesions are animal welfare indicators for conditions related to wet bedding, the welfare risk from adhering to today's requirements for ventilation capacity may be considered as high. Although there is a high incidence of air sacculitis in turkeys, data indicating that this is directly related to air quality parameters are lacking.

b. At which levels of dust, noise, temperature, air humidity and gas concentrations is turkey welfare impaired?

The highest recommended concentrations of dust and gases in turkey stables are:

Dust	3.4 mg/m^3
Inhalable dust	1.7 mg/m^3
Ammonia	20 ppm
H_2S	0.5 ppm
CO	50 ppm
CO_2	3000 ppm
Relative humidity	50 – 70 % (the recommended range)
Air temperature	34 °C – 16 °C

ToR 5 Bedding

a. **What are the main risk factors for reduced animal welfare as a consequence of unsuitable bedding?**

Skin ulcerations like foot pad dermatitis (FPD) and chestburns (focal dermal necrosis, FDN) are significant welfare problems in turkey production. Unsuitable bedding is the main cause of these problems. Causes of high humidity in the litter are leakages from the drinkers and high water intake, and wet droppings or diarrhoea caused by gut infections. If the humidity of the litter is too high, feathers can become dirty and the levels of ammonia in the air may be elevated. FPD and FDN may then develop. Very low litter humidity may also cause problems related to compromised air quality (dust). A level of 25-35 % humidity in the litter is considered optimal in broilers, and these levels are probably also appropriate for turkeys, but a normal range for turkeys is not described in the literature.

b. **What measures for risk reduction could be applied?**

The most important risk reduction measure is to keep the litter sufficiently dry during the whole poultry house at all stage of the production cycle. Foot pad dermatitis can develop at any age from Day 1. Many factors need to be properly controlled. Measures should be taken to prevent leakage from the drinkers or from the drinking nipples on the water lines/pipes. If leakage occurs the wet litter must be removed immediately and replaced by dry litter. Ventilation capacity and heating sources available must be sufficient to keep the litter dry during the entire production cycle. Preventive measures (e.g. coccidiostats) should be used to ensure good gut health, and any enteric diseases must be diagnosed and treated as fast as possible.

ToR 6 Feeding and watering

a. **What is the risk for reduced animal welfare by applying today's feeding systems, feed composition and feeding routines?**

Failure of the feeding system is considered to be a low risk to turkey welfare, whereas there is a moderate risk for turkey welfare in connection to inappropriate diet, quality of drinking water, as well as failure of the drinking system. Appropriate management during the first days of life is important. The probability of inappropriate feed is very low, but the consequences of inappropriate feed composition, as well as inadequate supply and quality of water, are serious.

b. **What measures for risk reduction could be applied?**

Appropriate monitoring of health and production parameters and compliance with feed industry quality assurance systems and KSL (Kvalitetssystemet i landbruket, Agricultural Quality System) recommendations would reduce the risk described in 6a.

ToR 7 Lighting regime

a. **What is the necessary brightness for turkeys to carry out normal activities and see each other clearly?**

Turkeys need a brightness of at least 5 lux in order to see each other clearly, but prefer higher light intensities if given the choice.

b. **Is there a risk of reduced animal welfare when using the level of brightness given in ToR 7a, for instance increased risk of pecking?**

There is potentially a low risk of reduced welfare associated with recommended light levels (5 lux) given that turkeys prefer higher light intensity levels. Satisfaction of this preference should be weighed against the assumedly increased probability of feather pecking and cannibalism at higher light intensities.

c. **Is there a risk of reduced animal welfare when using the stated recommendations on brightness from Aviagen or from the industry?**

There is a low risk of reduced welfare associated at the recommended light levels recommended by the industry (5-10 lux) or Aviagen (10-20 lux) although turkeys apparently prefer higher light intensity levels. Satisfaction of this preference should be weighed against the assumedly increased probability of feather pecking and cannibalism at higher light intensities. The farmer should therefore have a flexible approach to regulating the light intensity according to the behaviour of the turkeys.

ToR 8 Animal welfare indicators

a. **Which indicators are suitable for considering welfare in turkeys?**

Performance indicators such as growth rate and feed intake can only be interpreted with regard to welfare in the context of other information. However, they may be useful indicators for the farmer, as good growth rate can only be achieved under conditions of good welfare and management (Bessei, 2013).

Mortality is usually low in these types of facilities. Infectious disease incidents are regarded as sporadic. Cannibalism, which usually is a sign of decreased welfare, may cause high mortality. Under these conditions mortality may be a useful welfare indicator.

Individual level

Skin lesions caused by cannibalism are usually assessed together with feather damage, as feather pecking and cannibalism are closely correlated. Skin lesions of the foot (FPD), of the chest (FUD, and focal dermal necrosis - FDN), and breast blisters, are important indicators of welfare both on-farm and at the abattoir. A scoring system for turkeys based on FPD has been proposed by Hocking et al. (2008) and Bessei (2013).

On-farm

Welfare legislation is usually based on minimum criteria for environmental factors. The direct effects on welfare of complying with these criteria are questionable or unknown, but are generally easy to control. Such environmental factors include:

- Stocking densities
- Light
- Ventilation and air quality
- Environmental enrichment
- Management
- Competence (farmer)

Additionally, the “transect walk” approach described by Marchewka et al. (2013) suggests that immobility, lameness, head wounds, dirty backs, and featherless animals could be useful parameters for recording welfare on-farm.

At the slaughterhouse

- Carcass condemnation causes and rate
- Foot pad lesions (FPD)
- Breast blisters (FUD and FDN)
- Air sacculitis
- Performance indicators

b. Which animal-based welfare indicators could be suitable for systematic registration of the welfare level of flocks? Specifically, NFSA would like an opinion on whether foot pad dermatitis is a suitable indicator for turkeys that could be used in the same way as for broilers.

Both foot pad lesions and breast skin lesions are valid welfare indicators, but involve handling the animals. These conditions, as well as air sacculitis, are valid for recording at the slaughterhouse.

As, due to the size of the birds, foot pad lesions and breast skin lesions are time-consuming and labour-demanding to assess, they are not suitable to use on turkeys kept for meat production at the on-farm level. A scoring system for turkeys based on FPD has been described.

The “transect walk” method for animal-based on-farm welfare assessment represents a promising method for systematic registration of the welfare level of turkey flocks. Findings recorded by this protocol correlate well with the results obtained by individual animal scoring.

ToR 9 Artificial insemination of parent stock

a. What is the risk of reduced animal welfare due to artificial insemination of turkey parent stock?

The risk of reduced animal welfare due to use of artificial insemination (AI) in turkeys is associated with routine management, the frequent handling of the toms and hens, and the potential lack of competence of the handler. Feed deprivation and damage/haemorrhage caused by AI are considered as moderate welfare risks. Herding/catching and handling are associated with a low animal welfare risk. Because of the heavy weight of the toms and the frequent mating necessary to ensure good fertility of hatching eggs, a natural mating process would injure the hens, and therefore the artificial procedure is preferable despite the moderate welfare risk.

b. What is the risk of reduced animal welfare due to semen collection from parent stock?

The cloacae of male donors have been reported to show some degree of haemorrhage formation, the extent of which was dependent upon frequency of semen collection, the number of cloacal strokes, and individual differences in semen collectors' techniques. The risk of decreased welfare is considered as low. Herding/catching and handling are associated with a low animal welfare risk.

c. What measures for risk reduction could be applied?

As with handling, the knowledge and skills of the responsible workers are key for ensuring good animal welfare. Certification of responsible animal handlers and welfare monitoring of breeding animals could be considered as risk-reduction measures.

7 Conclusions

Welfare hazards related to the living area of commercial turkeys include a rather barren environment, lack of space for movement, resting, and avoidance, and inappropriate use of recovery pens. However, due to lack of data concerning the effect of environmental enrichments on animal welfare, it was only possible to perform risk characterisation on the use of recovery pens. Incorrect use of recovery pens is considered to represent a moderate risk to turkey welfare. A risk-reduction measure for animal welfare would be introduction of management guidelines for the use of recovery pens.

Stocking density interacts with other factors and due to lack of scientific literature on this topic, it is not possible to give a definitive answer regarding the level of stocking density that compromises turkey welfare. However, insufficient space for locomotion, body movement, resting/sleeping and escaping aggressive birds should be considered a hazard for turkey welfare in standard production systems, and is of increasing relevance with progressing age and size of the animals.

Low and high temperature and high levels of dust, ammonia, and other noxious gases are potential hazards for turkey welfare. Low temperature is considered a moderate risk to turkey poult welfare, whereas high temperature is considered a low risk. However, it was not possible to perform risk characterisation of dust, ammonia and other noxious gases, due to lack of data.

Wet bedding is a major hazard to turkey welfare and is a cause of foot pad dermatitis (lesions) and other skin lesions. As these skin conditions are widespread in Norwegian turkey production, wet bedding seems to represent a high risk to turkey welfare. To reduce the welfare risk of wet bedding, it is essential that the litter is kept dry by minimising the likelihood of it becoming wet, by replacing wet litter and by establishing optimal ventilation and heating.

Insufficient diet, inappropriate quality of drinking water and failures in the feeding- and drinking systems are potential hazards for turkey welfare. The probability of turkeys being exposed to the potential hazards related to feeding and drinking is low. However, due to serious consequences, the risk for animal welfare is considered moderate. Failure of the feeding system is considered a low risk to turkey welfare, whereas there is a moderate risk associated with inappropriate diet, poor quality of drinking water, as well as failure of the drinking system.

Light intensities that are too high or too low, and inappropriate light cycles are hazards for turkey welfare, representing moderate welfare risks.

Stress or injuries caused by herding and catching of the turkeys prior to semen collection (SC) or artificial insemination (AI), by handling, and technical procedures in connection with SC/AI and feed deprivation prior to insemination are all considered to be hazards for turkey welfare. Damage/haemorrhage caused by the AI procedure is considered a moderate risk to turkey welfare, as is feed deprivation prior to insemination. Haemorrhage caused by the SC procedure is considered to be a low welfare risk, together with stress or injuries inflicted by herding/catching and by handling in connection to both SC and AI procedures. To ensure good animal welfare when performing SC and AI, knowledge and skills of the responsible workers are of key importance.

Adherence with revised and detailed legislation on keeping turkeys, together with guidelines from the industry and systematic revisions by farmers, industry and the competent authorities, would be an overall measure to reduce welfare risks in turkeys. Encouraging farmers to follow up the good practices that are presented in the action plan for animal health and welfare for poultry 2014-2017, launched by the industry, may contribute to this reduction.

The “transect walk” method represents a promising method for systematic on-farm registration of welfare in turkey flocks. Foot pad lesions, breast skin lesions and the frequency of air sacculitis are valid animal welfare indicators, that are appropriate and feasible for recording at the slaughterhouse. Implementing systematic recording of these indicators would assist in generating an evidence-based document of the turkey welfare situation.

8 Data gaps

- There is a general need for systematic testing to determine whether findings from one turkey hybrid are applicable to other hybrids.
- Knowledge on the effect of environment enrichment and provision of perches and barriers in different constellations in the room on turkey behaviour and welfare is required.
- The appropriate animal densities for turkeys have not been determined, and more data on this aspect is needed.
- Practical experience with commercial poults shows that they usually stand still and do not try to escape when they are being pecked by other birds. This observation suggests that it is uncertain whether a turkey will actually escape from another aggressive bird, even if there is sufficient space. However, this observation needs to be backed by scientific evidence.
- Data on the need of commercial hybrids to dust bath and ground scratch are lacking.
- There is a lack of data on exposure of Norwegian turkeys to dust, ammonia and other noxious gases. Furthermore, studies are needed to evaluate whether there is an association between air quality parameters and the development of air sacculitis and other respiratory conditions.
- More data on light recommendations and bird densities with regards to the bird's welfare are needed. The requirements in the current Regulations are not grounded on scientific evidence.
- With respect to parent stock, data on methods for assessing the insemination method and semen collection technique are lacking.
- There is a lack of production data and data on health and welfare in breeding flocks. In order to be able to assess the health and animal welfare of breeding turkeys, adequate registration of animal welfare indicators, health parameters and production parameters is necessary.

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