DELIVERABLE

DL.2.2.1: LIST OF CANDIDATE ICEBERG INDICATORS FOR PRIORITY AREAS 1&2 TO BE DEVELOPED ON FARM WITH DESCRIPTION OF THE METHOD, VALIDITY, RELIABILITY AND FEASIBILITY.

<u>Activity 2:</u> Animal welfare indicators, methods for the assessment and methods of improvement

Article 96 (b): Providing scientific and technical expertise for the development and application of the animal welfare indicators referred to in point (e) of Article 21(8).

The Article 21 (8) (e) refers to possible rules on the cases and conditions where official controls to verify compliance with animal welfare requirements may include the use of specific animal welfare indicators based on measurable performance criteria, and the design of such indicators on the basis of scientific and technical evidence.

Article 96 (c): Developing or coordinating the development of methods for the assessment of the level of welfare of animals and of methods for the improvement of the welfare of animals.

<u>Sub-activity 2.2:</u> The identification of 'Iceberg Indicators'

<u>Objectives:</u>

To develop "Iceberg Indicators" that can be used by official inspectors to obtain a quick overview on possible welfare problems related to the priority areas 1 and 2.

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1. Introduction

Competent Authorities and official inspectors emphasise the need for 'Iceberg Indicators', as these are seen as valuable tools in providing a general picture of the welfare status, enabling to support targeted inspections. In response to their request, potential Iceberg Indicators have been identified based on the work done in Sub-activity 2.1 of the previous year's programme. The purpose of this deliverable is to provide a list of candidate Iceberg Indicators preferably Animal Based for broiler chickens and laying hens on farm.

Iceberg Indicators are indicators that can be used to obtain a quick overview on possible welfare problems as they may reflect several welfare issues in an integrative manner. They provide an overall welfare assessment, just as the protruding tip of an iceberg signals its submerged bulk beneath the water's surface (FAWC, 2009). Iceberg Indicators are not strictly linked to one specific legal requirement, but might be associated with several requirements. The use of these 'Iceberg Indicators' will provide a rapid qualitative or quantitative knowledge of the level of welfare of the flock on farm, during transport or at slaughter. Ambiguous potential iceberg indicators (see definition below) will not be described in this document.

The experts of EURCAW-Poultry-SFA, based on outcomes of the work done in Sub-activity 2.1 of the previous year's program literature review and expert opinion, have agreed to consider the following list of candidate iceberg indicators:

- Mortality (both for broilers and laying hens)
- Litter quality (broilers)
- Walking ability (broilers)
- Feather cleanliness (broilers)
- Pecking Damages (laying hens)
- Keel Bone Damage (laying hens)

In this deliverable, each of the above-mentioned Iceberg Indicators will be shortly described with its method and its validity, feasibility and reliability (see definitions below). Validity, feasibility and reliability will be rated according to the scientific and expert knowledge.

The assessment of the state of the on-farm welfare of broilers and layers at the slaughterhouse will be carried out in the next work programme (2022).

2. Definitions

Iceberg indicator: Indicator reflecting major welfare issues in an integrative manner in order to enable an initial overview on the welfare state. (Iceberg indicators are not meant to replace a full and precise assessment of the welfare of animals but to give only a rough overview to target inspections).

Method: a system of application of the indicator for the assessment of animal welfare.

Validity: The extent to which the method of an indicator is in terms of providing information or assessment on welfare issues.

Reliability: The extent to which results are largely the same when the same observer repeats assessments after receiving reasonable training or the agreement between two or more observers after they have received reasonable training.

Feasibility: Capacity to be applicable to different housing systems and at least have the potential to be applied on-farm (in terms of material needed, time required, and animal manipulation).

Ambiguous iceberg indicators: indicators that in some contexts may suggest poor welfare while the opposite conclusion could be drawn under other circumstances (FAWC, 2009). For example: a high number of antibiotic treatments in a flock may be indicative of poor welfare, but a low number of treatments on the contrary does not necessarily mean the opposite, since the birds although ill may not have been treated, leading to other serious welfare consequences. Other examples can be production traits (weight gain, laying rate etc.) as performance is not always positively correlated to welfare.

3. Methodology Used

Validity, Reliability and Feasibility of each iceberg indicator are estimated according to the table below.

	X (low)	**XX** (moderate)	**XXX** (high)
Validity	• Literature shows low correlation between Animal Welfare and the indicator/method *And/or* • Average score from 0 to 2 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of poor level of validity	• Literature shows moderate correlation between Animal Welfare and the indicator/method *And/or* • Average score higher than 2 and lower than 4 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of moderate level of validity	• Literature shows high correlation (with causality link) between Animal Welfare and the indicator/method. *And/or* • Average score higher than 4 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of high level of validity
Reliability	• Literature shows low reliability *And/or* • Average score from 0 to 2 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of poor level of reliability	• Literature shows moderate reliability *And/or* • Average score higher than 2 and lower than 4 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of moderate level of reliability	• Literature shows high reliability *And/or* • Average score higher than 4 (on a scale of 5) in Competent Authorities opinion *And/or* • Expert opinion with experience of high level of reliability
Feasibility	• *Material needed:* High cost/low availability material (*e.g.* gas meter, dust meter) *And/or* • *Time to be performed:* More than 60 min *And/or* • *Ease to access:* Difficult access or not possible in more than one type of structure *And/or* • *Animal manipulation:* Biological sampling (*e.g.* blood, swab)	• *Material needed:* moderate cost of the material (*e.g.* thermometer, hygrometer) *And/or* • *Time to be performed:* 30-60 min *And/or* • *Ease of access:* Not easy to access (*e.g.* to upper tiers) or not easy to apply in all farm/slaughterhouses *And/or* • *Animal manipulation*: Some animal manipulation with no biological sampling (*e.g.* check foot pad)	• *Material needed:* no or low-cost material (*e.g.* tape measurer) *And/or* • *Time to be performed:* less than 30 min *And/or* • *Ease of access:* Easy to access and feasible in all kind of structure *And/or* • *Animal manipulation :* No animal manipulation

4. Common Indicator: Mortality

Definition: any animal found dead in the flock and recorded in the farm mortality sheets (including animals that are culled for health and welfare reasons).

Method: divide the number of dead birds by the number of birds placed in the flock (percentage of mortality).

Mortality is an important welfare indicator covered by Directive 2007/43/EC. It is reported in different ways such as: daily, weekly, cumulative mortality etc. A study conducted by Tabler et al. (2006) shows that a broiler flock experiencing a mortality of more than 7.53% has welfare issues. The OIE also recognizes that any unforeseen increase in mortality could reflect an animal welfare problem (OIE Terrestrial Animal Health Code 2021 VOLUME I CHAPTER 7.10).

The total mortality average in broiler flocks in UK is reported to be as low as about 2.5% (Butterworth, 2004), but is more likely to be in the range from 4 to 6.5% (Hall, 2001, Dawkins et al., 2004).

Evaluation of the method

The increase in mortality can be related to poor farm management and can be an indicator of welfare, health, nutritional and managerial problems of the farm itself. The mortality assessment is carried out through the inspection of daily mortality records; consequently, it is a feasible and reliable method. Validity is limited by the fact that while high mortality is indicative of welfare issues, low mortality does not necessarily mean that the animals are in a good welfare status. It is difficult to set thresholds for this indicator, however, farmers, are alarmed during their daily work by any increase in mortality in respect to the previous days and will take action based on this indicator of welfare on farm.

Indicators	Validity	Feasibility	Reliability
Mortality	++	+++	+++

5. Broiler chicken indicators

5.1. Litter quality

Poultry litter is organic waste consisting a mixture of poultry manure, spilled feed, feathers, and bedding materials. In the broiler house, litter serves to absorb moisture, dilute faecal material and provide insulation and cushion between the birds and the floor (Dunlop et.al. 2016). Providing chickens dry and friable litter is a key objective for reducing the likelihood of health and welfare issues.

The requirement to provide access to dry and friable litter is enshrined in legislation. Monitoring and scoring systems of litter moisture have been developed for this purpose. The Council Directive 2007/43/EC (EU 2007) and animal welfare standards, specify the quality of litter and conditions to be maintained throughout production.

Many factors may give rise to poor litter quality such as: drinker design and management, air change rate and house environment, litter material and depth, stocking density, nutrition, flock health etc. (DEFRA, 1994). All these factors can be assessed through the evaluation of litter conditions, particularly litter moisture. The quality of the in-house environment is highly dependent upon litter quality. The litter environment is ideal for bacterial proliferation and ammonia production. Litter quality represents an important welfare indicator, as poor litter management could potentially lead to an increased risk of pathogens, dust and ammonia overexposure that effect the health and welfare status of broiler chickens.
Litter quality is therefore not only a crucial requirement but also a strong animal welfare indicator. For this reason, monitoring and scoring of litter moisture represents a valuable resource-based animal welfare indicator assessing all these factors representing a valuable iceberg indicator. Assessing litter moisture, however, is not straightforward, as there are wide differences in litter moisture content throughout the barn. Additionally, exposure time of animals to wet litter may vary in field conditions in terms of the time spent around feeding or drinking areas which are particularly wet litter spots.

Description of the method of assessment

A method is proposed by Vinco et al. (2018) and used in the Classyfarm protocol (see DL 3.2.2 2020). To perform the litter evaluation, the inspector must assess litter in three selected points of approximately 1 square meter at 6–7 m from the entrance of the shed (one in the middle of the barn, one under the feeder and one under the drinker line). In each evaluation point, the assessor should give a score (1-10), describing the wetness and the friability of the bedding material based on the provided checklist.

Table 1: Description of the visual scores for friability and wetness in the Classyfarm Protocol

Score	Friability Description	Wetness Description
1	Completely caked	Wet litter, water is appearing by pressure on the litter of the total area
2	80-90 % area caked	Wet litter, water is appearing by pressure on the litter beneath drinkers
3	70-80 % area caked	Wet litter, no water is appearing by pressure on the litter
4	60-70 % area caked	Wet litter dark coloured. Litter can be pressed into ball-shape
5	50-60 % area caked	Wet litter, dark coloured. Larger ridges*** beneath drinkers

6	40 % area caked	Almost dry litter, small ridges** beneath drinkers. Litter between drinkers and feeders is still friable
7	30 % area caked	Almost dry litter, dark coloured beneath drinkers and in other areas light coloured, ridge formation just started* beneath drinkers
8	10 % area caked	Almost dry litter, light coloured, no ridges beneath drinkers
9	Friable litter, small caked areas	Dry litter, light coloured
10	Friable litter, no caked areas	Very dry litter (only observed at start)

*Just started ridges: slightly visible;**small ridges: well visible beneath drinking line; ***larger ridges: well visible, overmatching the drinker rim

The mean between the three values identifies the litter's final score. When the mean wetness and/or friability score is below 5, litter is considered "Inadequate"; when both the scores are between 6 and 8, the litter is "Adequate"; when both the scores are 9 or 10, the litter is "Optimal".

Evaluation of the method

Regular visual inspection of litter (e.g. during daily flock inspection) and avoidance of high moisture contents from the first week of age onwards appears to be the key strategy to avoid foot pad dermatitis and other health problems. In term of validity, feasibility and reliability this method is simple to be used and offers two advantages: it does not require much training and the results are repeatable, homogeneous when performed by different operators.

Indicators	Validity	Feasibility	Reliability
Litter quality	+++	+++	++

5.2. Feather cleanliness

Feather cleanliness means the absence of large patches of dirty plumage on breast, and a clean plumage. Birds use feathers to keep warm, to protect themselves from moisture, dirt and skin infections. However, the plumage can become wet or soiled with e.g., litter of poor quality, faecal matter and dirt. With outdoor access, chickens are exposed to variable weather conditions and thus an intact plumage, which is essential for thermoregulation, is particularly important. When the feathers are wet or soiled by litter they may lose their protective properties, having negative effects on welfare of birds (Greene et al., 1985; Welfare Quality 2009). Plumage condition can be related to many different factors: lack of dust bathing, poor litter quality, lack of ventilation, subclinical coccidiosis or necrotic enteritis and low biosecurity (Otto van Tuijl, 2020). Dust bathing is an essential component of feather maintenance and this requires good, dry and friable litter (Pickett, 2018). Maintaining good litter quality at all times is therefore important and immediate action should be taken if the litter become caked or wet. Poor litter quality is normally caused by incorrect ventilation, water leaking from drinkers or gut health problems (DEFRA, 1994).

Description of the method of assessment

Feather cleanliness is easy to assess at the slaughterhouse and could be an asset in gaining information regarding the birds' living conditions. It can also be assessed as part of on-farm inspections, prior to or at the time of harvesting. A method has been developed for this purpose, based on the scoring system described in the Welfare Quality protocol (2009).

On farm; the inspector walks slowly inside the house, catching the birds one by one (10 birds in 10 different locations). He examines the breast of the birds using a recording sheet according to a precise classification (scoring from 0 to 3):

Score and descriptions for cleanliness of breast feathers:

0 = Plumage is clean
1 = Slightly dirty plumage
2 = Moderate patches of dirty plumage on breast
3 = Large patches of dirty plumage on breast/breast is completely covered in dirty plumage

Figure 1: Breast cleanliness scores from the Welfare Quality Protocol (2009)

Evaluation of the method

Assessment of the feather cleanliness of broilers provides useful information on the bird's welfare. Feather cleanliness is correlated with contact dermatitis and lameness for individual birds or may be associated with the environment and production system providing indications of the management quality and litter humidity (Arnould et al., 2009).

Therefore, monitoring and scoring of feather cleanliness represents an important iceberg indicator. The method described above has good validity providing fundamental information on the welfare of broilers. In terms of reliability, it may have limits related to the inspection which is subjective and for this reason requires training to avoid inter-observer variability. Feasibility on farm may have a limit regarding the difficulty of catching the birds. Moreover, the method requires inversion of the birds which causes stress, as it is unnatural for chickens to stay upside down, and since birds do not have a diaphragm, the abdominal organs will exert pressure on the organs in the chest.

Indicators	Validity	Feasibility	Reliability
Feather cleanliness	+++	++	+

5.3. Walking ability (gait score)

Walking ability is the capability to use both limbs in a normal manner.

Broilers are susceptible to develop a variety of infectious and non-infectious musculoskeletal disorders. These disorders may lead to lameness and to gait abnormalities. Broilers that are lame or have gait abnormalities may have difficulty reaching the food and water and may be trampled by other broilers. Walking ability in broiler chickens is often compromised and is a primary welfare concern as it is considered painful. Identifying risk factors associated with lameness may provide important tools for flock welfare assessment. EFSA (2010) reported causes of leg problems to be high stocking density, light schedule, low light intensity, inappropriate diet, diet composition, barren environment, fast growth rate, high body mass, unbalanced body conformation, reduced mobility, inappropriate incubation process and poor hatchery hygiene. A study carried out in 50 commercial broiler chicken farms demonstrated that lameness was associated with a range of welfare indicators, including hock burns, footpad dermatitis, feather cleanliness and condemnations at slaughter, suggesting that suboptimal environmental conditions impact on walking ability (Granquist et al. 2019).

Consequently, monitoring and scoring of walking ability represent an important iceberg indicator that can be used to assess leg disorders. Gait score is widely used to assess broiler leg health in commercial flocks. There are several gait scoring systems available, the most widely used methods are described below.

Description of the methods of assessment

Welfare Quality (2009) (five-point gait scoring system)

Gather approximately 150 birds using a catching pen. For very flighty birds it may be necessary to catch small pens of birds. Each bird is individually encouraged to walk out of the pen and is scored as it does so. Birds are classified according to these criteria:

0. Normal, dextrous and agile
1. Slight abnormality, but difficult to define
2. Definite and identifiable abnormality
3. Obvious abnormality, affects ability to move
4. Severe abnormality, only takes a few steps

The flock average gait score can be calculated by the sum of gait scores of all birds assessed, divided by the total number of birds assessed. Scores 3 and 4 underline a poor flock management that will reflect poor welfare.

Kestin et al. (1992) (six-point gait scoring system; also called the Bristol scale) has developed a method for measuring the prevalence of leg weakness by assessing the walking ability of broilers. The methodology consists of empirical repetitive visual observations of how birds walk on a surface. The system is divided into six categories, from completely normal to immobile. The method was found to give consistent result when performed by the same people.

0. None No detectable abnormality.
1. Detectable but unidentifiable abnormality Slight defect in walking ability that is difficult to define. An uneven gait.

2. Identifiable abnormality that has little effect on overall function Definite and identifiable defect in gait but with little hindrance of movement.
3. Identifiable abnormality that impairs function. Obvious gait defect, which affects ability to move about (e.g., limp, jerky or unsteady stride, or splaying of a leg).
4. Severe gait defect. Capable of walking with difficulty when driven or strongly motivated. Squats at first opportunity.
5. Complete lameness. Bird cannot walk. May shuffle on shanks or hocks with assistance of wings.

A.B. Webster, B.D Fairchild, T.S Cummings, P.A. Stayer (2008) (Three-point gait scoring system). Gait-The 3-point (3PT) gait scoring system that is currently being used on commercial farms in USA, seeks to identify broilers as
Gait score: 0 having no impairment of walking ability. Criterion: Bird can walk at least 5 ft with a balanced gait. Bird may appear ungainly but with little effect on function.
Gait score: 1 having obvious impairment but still ambulatory. Criterion: Bird can walk at least 5 ft but with a clear limp or decidedly awkward gait.
Gait score: 2 having severe impairment and not able to walk without great difficulty. Criterion: Bird will not walk 5 ft. May shuffle on shanks or hocks with assistance of wings.

Evaluation of the methods

The described methods are used in several animal welfare assessment schemes and appear to be very useful in obtaining an objective report. The visual inspection of walking ability (i.e. gait scoring) offers the advantage of allowing a non-invasive evaluation of a large number of birds in a short period of time. However, it requires training in order to be efficiently performed particularly in terms of repeatability and to avoid crowding of the animals within a flock when carried out. The many factors and measures associated with gait scoring have empirically established its validity. However, published within-observer and inter-observer reliabilities are uncertain. According to Cordeiro et al. (2009), the evaluation of gait score to detect locomotion problems of broilers under rearing conditions seems subjective and difficult to be properly performed. In a study (Webster et al. 2006) two observers scored each bird according to the three-point gait scoring system, and 2 other observers simultaneously scored the same birds according to the six-point gait-scoring system.
The three-point scale system proved to have a good intersystem agreement with the other scoring systems when used on commercial farms. Both the three-point scale and the Bristol scale were found to have substantial observer reliability, but between-observer agreement was somewhat greater for the three-point scale system on commercial farms. The simplicity of the three-point scale system may promote observer reliability for gait scoring commercial poultry flocks.

	Validity	Feasibility	Reliability
Five-point gait scoring system	+++	++	+
Three-point gait scoring system	+++	+++	+++
Six-point gait scoring system	+++	++	++

6. Laying hen indicators

6.1. Feather pecking

Severe feather pecking consists of forceful pecks and pulls of feathers that are frequently eaten and results in feather loss especially on the back, vent and tail area (Featherwel, 2013). Feather pecking and its damages are a general welfare problem in laying hen flocks because the removal of feathers is painful and stressful for the animals. It can also increase the risk of diseases and their spread through all the flock, and eventually increase mortality. Feather pecking is a multifactorial problem but severe feather pecking is generally related to feeding and lack of opportunities for foraging behaviour (Rodenburg et al., 2013). It seems to increase when birds are in conditions where they have difficulty coping with environmental stressors.

Description of the method of assessment

To assess the feather pecking damages, different parts of the body are inspected. According to the body part, provided information may differ. Damages to the back and rump's feathers usually show feather pecking; damage to the neck's feathers can be caused by abrasion; feather loss to the belly can be seen in highly productive animals or caused by vent pecking (WelfareQuality®, 2019).

For example, in the Welfare Quality Protocol (2019), on 100 hens scored individually on a 3-point scale, four distinct parts of the body are assessed: neck, back and rump, and belly.

0 = no or slight wear, (nearly) complete feathering (only single feathers lacking);

1 = moderate wear, i.e. damaged feathers (worn, deformed) or one or more featherless areas < 5 cm in diameter at the largest extent;

2 = at least one featherless area ≥ 5 cm in diameter at the largest extent

In the LayWel system (Tauson et al., 2006), a 1-4 scoring scale is used on the neck, breast, vent, back, wings and tail (with worst condition scored as 1 and better condition at 4). No descriptive definition exists for this scoring scale, only several pictures as examples below (Figure 2).

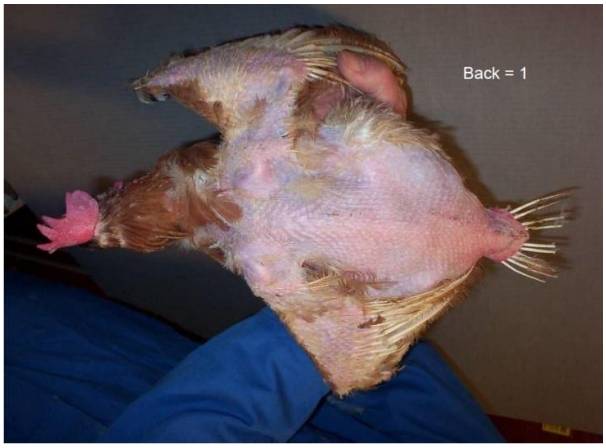


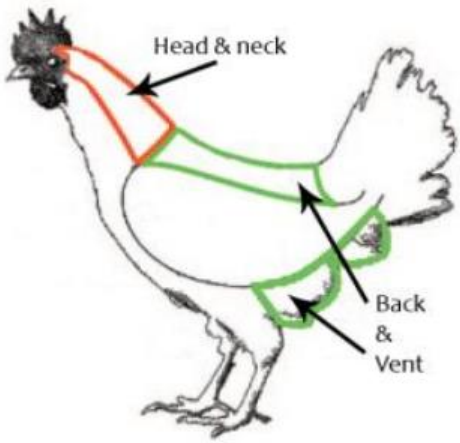
Figure 2: Examples of Pictures from the LayWel Systems (Tauson et al., 2006)

In the AssureWel feather loss measures, 50 birds are assessed visually without handling them (5 animals in 10 different locations) (Main et al., 2012). The head/neck area and back/vent area of the birds are separately scored as follows:

0: No/Minimal feather loss. No bare skin visible, no or slight wear, only single feathers missing.

1: Slight feather loss. Moderate wear, damaged feathers or 2 or more adjacent feathers missing up to bare skin visible < 5cm maximum dimension

2: Moderate/Severe feather loss. Bare skin visible ≥ 5cm maximum dimension



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Evaluation of the methods

The validity, feasibility and reliability of these three methods could vary. The differences in the sample size could affect the validity of this indicator to highlight the welfare issues of a whole batch. Handling the animals or assessment from a distance could also influence the validity. Indeed, studies have shown that assessing feather damage without handling the animals is still valid although scores tend to be better (more accurate) when the animals are closely inspected (Kjaer et al., 2011; Decina et al., 2019). Feasibility of this indicator during an inspection on farm is also linked to the sample size and the presence/absence of handling. Finally, the inter- and intra-reliability differ between methods (Decina et al., 2019). Simpler scoring systems seem to be easier to use and with less inter-reliability issues. Inter-reliability may also differ between body parts. The back area seems to be easier to score than breast or belly (Kjaer et al., 2011). As an example, Decina et al. (2019), have showed that AssureWel scoring system was better than LayWel from intra- and inter-observer reliability point of view for the back region of the body.

	Validity	Feasibility	Reliability
Welfare Quality	XX	X	XXX
LayWel	XXX	X	XX
AssureWel	XX	XX	XXX

6.2. Keel Bone Damage

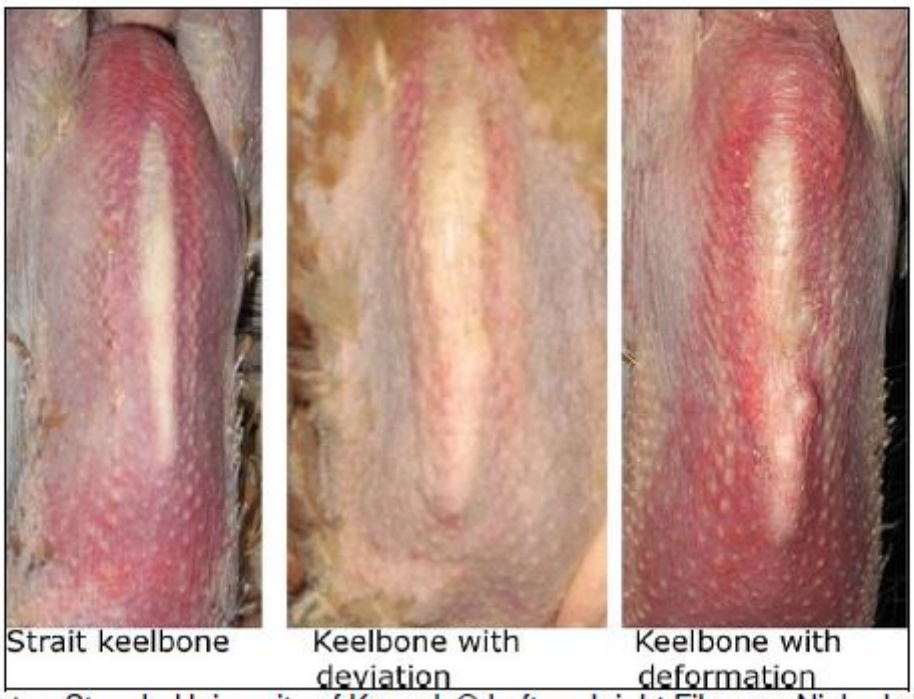
Keel bone damages are a major problem in laying hens' farms and occur in all production systems. The damages of the keel bone can be classified into two categories: fractures and deviations. Keel bone fractures are characterized by sharp bends, shearing, and/or fragmented sections of the keel bone. They may extend from the ventral to the dorsal surface in the sagittal plane, though they can also be cranial to caudal, or a combination of both (Casey-Trott et al., 2015). The keel bone deviation is a deformation of the keel bone which is supposed to follow a straight line (Riber et al., 2018). The deviations can be vertical or horizontal, showing an s-shaped appearance, bumps, or notches (Kappeli et al., 2011). Keel bone fractures are painful for laying hens and lead to negative affective states that may last at least three or four weeks (Armstrong et al., 2020). However, there is a gap of knowledge about the painfulness of keel bone deviation. Keel bone damages are an important welfare issue in laying hens and are related to multiple parameters such as bone fragility (consequence of osteoporosis, anatomical characteristics), genetics, or non-adequate perches (e.g (Fleming et al., 2004; EFSA, 2015; Harlander-Matauschek et al., 2015; Stratmann et al., 2015; Riber et al., 2018)). Fractures happen following a short-term event, as well as high energetic impacts, whereas deviations seem to result from extended perching behaviour and are related to long-term pressure on the keel bone (Pickel et al., 2011; Stratmann et al., 2015). Lastly, some risk factors are now known as major for the development of keel bone fractures: hen size (heavy hens at end-of-lay have fewer fractures), age at onset of lay (older the hens are at onset of lay, the lower will be the flock fractures prevalence at end-of-lay) and daily egg weight at onset of lay (the production of heavier eggs at onset of lay result in higher fractures prevalence) (Thøfner et al., 2021)

Description of the method of assessment

Keel Bone Damages can be assessed using several methods, like X-radiation (X-ray), ultrasonography, peripheral quantitative computed tomography (pQCT) or palpation and visualization with the naked eye (Casey-Trott et al., 2015). However, except for palpation and visual assessment, these methods

cannot be easily performed during an inspection because of the equipment and specialized facilities required as well as their cost. Nevertheless, palpation assessment underestimates the true prevalence of keel bone fractures (difficulty to identify the levels of fractures, localisation of the fractures hardly accessible)(Thøfner et al., 2021).

A palpation protocol is described in the Welfare Quality Protocol (2009), by taking 100 hens in the barn randomly in several areas (litter, slatted floor, perches). The number of places to take hens is dependent on the housing system, in case of doubt, hens are collected from 10 different locations. Then, the keel area is inspected by palpation and its state is evaluated: keel bone straight, no deviations, deformations or thickened sections, deviation or deformation of keel bone (thickened sections included).



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Extract from Welfare Quality Poultry Protocol (2009)

Evaluation of the methods

As explained above, palpation assessment underestimates the true prevalence of keel bone fractures (Thøfner et al., 2021), resulting in a low level of validity of this indicator and method. Sampling 100 hens to evaluate the state of their keel bone takes time, this indicator assessed using the above-described method is thus hardly feasible during an inspection. In addition, evaluating keel bone damage by palpation could be subjective especially without specific training (Harlander-Matauschek et al., 2015) and Competent Authorities rated its reliability at 3.2 of 5.

	Validity	Feasibility	Reliability
KBD assessment with the Welfare Quality Protocol	X	X	XX

7. General table of iceberg indicators

Table 3: Validity, feasibility and reliability of the Iceberg Indicators

Indicators	Validity	Feasibility	Reliability	Broilers	Layers
Mortality	XX	XXX	XXX		
Walking ability (gait score)	XXX	XX	X		
Litter quality	XXX	XXX	XX		
Feather cleanliness	XXX	XX	X		
Feather Pecking	See 5.1.				
Keel Bone Damage	X	X	XX		

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