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Evaluation of animal welfare in on-farm self-assessments – development of a reference framework with target and alarm values based on a Delphi survey

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To assist livestock farmers in the evaluation of their livestock's welfare based on results from on-farm self-assessments, a reference framework with target and alarm values for animal welfare indicators was developed. The first step in this development process was a two-stage Delphi survey in 2018. The survey involved experts from science, consultancies, administrations, farms, producer associations, animal welfare organisations, competent veterinary authorities and processors from the beef, pork and poultry sectors. The response rates varied depending on the animal species, ranging between 19% and 36%. For each animal welfare indicator surveyed, the experts submitted up to 60 suggestions for reference values for cattle, up to 69 for pigs and up to 21 for poultry. In a multi-stage process, the results of the Delphi survey were compared with results reported in the literature and with data from field studies. Based on discussions in panels, the experts proposed values for a reference framework based on these results, in some cases in modified form. Some examples of these modifications are given in the paper.

The animal welfare status in livestock farming is often criticised in public discussions (Isermeyer 2019, WBA 2015). Animal protection – i.e., ensuring a certain level of animal welfare – has been enshrined as a societal goal in the constitution since the amendment of German Basic Law in 2002 (Article 20a). Since 2014, legislation has required all livestock farmers to perform on-farm self-assessments (referred to as 'Betriebliche Eigenkontrolle') to ensure compliance with the requirements for the keeping and care of animals stated in § 2 of the German Animal Welfare Act (TierSchG): "The livestock farmer shall collect and evaluate relevant animal welfare indicators for on-farm self-assessment" (§ 11, 8 TierSchG 2006). However, the legislation does not specify which indicators are to be collected, how often they are to be collected or how the results are to be evaluated. The Scientific Advisory Board for Agricultural Policy at the Federal Ministry of Food and Agriculture (WBA 2015) sees the approach of routinely collecting animal-related indicators to be an important success factor for developing sustainable animal husbandry. Recommendations by the Farm Animal Husbandry Competence Network (Kompetenznetzwerk Nutztierhaltung 2020) and the Commission on the Future of Agriculture (Zukunftskommission Landwirtschaft 2021) also support this approach. In German language, both the

term 'Tierwohlindikatoren' (animal welfare indicators) and the term 'Tierschutzindikatoren' (animal protection indicators) are interchangeably used in the literature and the Animal Welfare Act. Here, in English language, the more adequate term animal welfare indicators is used.

Management aids

To assist livestock farmers in carrying out on-farm self-assessments, experts have compiled indicators for the following species and farming purposes: dairy cows, calves, beef cattle, sows, suckling piglets, weaning piglets, fattening pigs, pullets, laying hens, broiler chickens and broiler turkeys. The animal welfare indicators can be used to identify those animal welfare problems that most commonly occur on farms (Zapf et al. 2017, 2015). Together with suggestions on how to collect them, these indicators were first published in practical guides in 2016. Subsequently, the second, updated editions were published for cattle (Brinkmann et al. 2020a), pigs (Schrader et al. 2020a) and poultry (Knierim et al. 2020a).

The guides are designed as management tools for the benefit of both, farm animals and livestock farmers. Farmers can identify farm specific animal welfare problems and problem areas by careful, regular recording of animal welfare indicators, and they can consequently check for specific welfare hazards on their farm. Hence, the assessment of indicators provides a valuable basis for farm management and evidence-based decision-making. Documentation of the results allows farmers to monitor changes over time and the success of any measures implemented.

Reference framework

For operational management decisions based on such a self-monitoring system, livestock farmers need reference values for the evaluation of results, i. e. for the identification of potential problems that require animal welfare improvement. In addition, an evaluation of the recorded animal-based indicators is prescribed by the Animal Welfare Act. However, so far a reference framework for this purpose is lacking. A reference framework for the evaluation of the recorded welfare indicators was therefore developed, applying a "traffic light" system (Figure 1) and taking account of the following aspects.
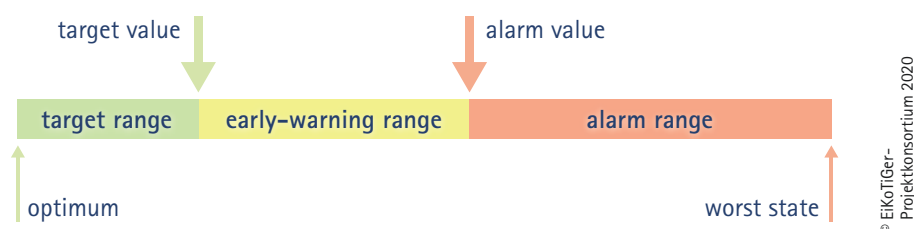
Figure 1: Reference framework for on-farm self-assessments – definition of threshold values, with ranges for the target value, early warning and alarm values according to the "traffic light" system

- The target value is based on achievable values in real-life conditions, and limits the target range. Although the aim is to optimise animal welfare, impairments during lifetime or of individual animals cannot be completely prevented. For this reason, as a rule, the target value cannot be zero.
- Short-term deviations from the target range due to unfavourable external conditions or events can occur and may be beyond the control of the livestock farmer. However, when such deviations occur repeatedly or permanently, it is an indication that there is a need to take action.
- The range between the target value and the alarm value is intended to serve as an early-warning range, as it allows farmers to identify problems in good time, thus prompting them to initiate measures.
- If the alarm value is exceeded, this should prompt livestock farmers urgently to take action. Then, if not already in the early warning range, livestock farmers should identify possible causes and take specific measures to improve the animal welfare state. If necessary, they should seek advice from extension services or veterinarians with a focus on production medicine.
- Identifying causes and rectifying problems often require a long period of time. Many animal welfare problems are multifactorial and can therefore usually only be addressed by extensive step by step changes of husbandry conditions. For such a process, regular self-assessments provide a particularly important source of feedback on the success of measures implemented to improve animal welfare.

To determine the reference values described above, as a first step a Delphi survey involving all relevant stakeholders was conducted. The Delphi method is a systematic, multi-stage survey procedure with a formalised questionnaire, which involves providing participants with feedback on the aggregated anonymised results from the previous round of the survey. The aim of many Delphi surveys is to identify and qualify the views of a group of experts on an unclear issue (Häder 2014). The results of such surveys serve to reduce heterogeneity so that, for example, limit values or intervention thresholds can be derived (Spoolder et al. 2014). The Delphi survey method has been implemented multiple times in the context of animal welfare and livestock husbandry (Bergschmidt et al. 2021, March et al. 2017, Soisontes 2015, Souza et al. 2018, Spoolder et al. 2014, Strüve et al. 2017, Whay et al. 2003). Some of these surveys were conducted on future husbandry or transport conditions. Others aimed to select test indicators for various applications, whereas others sought to define concrete evaluation parameters (thresholds), e. g. for funding programmes. The quality of the results of a Delphi survey depends predominantly on the selection of experts involved in the survey (Möhring and Schlütz 2010). The criteria for selecting these experts are as follows: involvement of an appropriate balance of stakeholder groups, which should, if necessary, take into consideration different geographical regions, the experts' knowledge on the topic under study as well as their relevant technical expertise (Loweridge et al. 1995, cited in Häder 2014).

The aim of the work was to develop a reference framework for on-farm welfare self-assessments on the basis of (1) the target and alarm values determined in the Delphi survey for each animal species and type of production (2) an extensive literature search on the prevalence and incidence of welfare issues in practice and (3) discussions and a consensus in three expert panels for each animal species – cattle, pigs and chickens/turkeys – with representatives of the relevant stakeholder groups. This article presents the Delphi survey and describes how the results were assessed and the reference framework was finalised in a multi-stage process which incorporated results from the literature, data from field studies and input from the expert panels.

Material and methods

Preparation and implementation of the Delphi survey

The Delphi survey was conducted in 2018 for cattle, pigs and poultry. It involved experts, who were familiar with the topic "animal welfare in livestock farming" due to their field of activity and who possessed expertise for proposing realistic reference values. Potential participants were contacted, but also individuals, associations or institutions were asked to forward the questionnaires to relevant persons or departments. This approach was based on the co-nomination technique proposed by NEDEVA et al. (1996), whereby experts from the specific area of interest are contacted with a request to nominate colleagues who are also established experts. An important selection criterion was to involve the relevant stakeholder groups in the field of "defining, collecting, assessing or safeguarding animal welfare in livestock farming" with partly differing priorities of interest. The following stakeholder groups were included in the survey:

- Administrative bodies: animal welfare officers and specialists of the federal states and local competent authorities
- Consultants: governmental and private education and consulting organisations, state research institutes
- Professional organisations and producer associations/groups for conventional and/or organic livestock farming
- Livestock farmers
- Animal welfare associations with activities in the field of farm animal husbandry
- Veterinary practitioners: herd veterinarians, animal health service providers, professional organisations
- Scientists: agricultural and livestock science as well as veterinary medicine
- Processors of agricultural products

A total of around 195 experts for cattle, 211 for pigs and 161 for poultry from all federal states of Germany and, in a few cases, from neighbouring European countries were asked to make proposals for reference values for the evaluation of data collected in on-farm welfare self-assessments. The Delphi survey was conducted in a two-stage procedure with a personalised e-mail letter. The e-mail letter contained an Excel® sheet with one spreadsheet per farm animal type, fill in instructions and information on the procedure and data privacy. The experts could enter their proposals for one target and one alarm value for each animal welfare indicator in the spreadsheet and add comments if necessary. Each indicator was briefly explained and links were provided to the illustrated score descriptions in the above-mentioned practice guides. The target and alarm values were defined as follows:

- "Target value: According to the current state of knowledge, there is no animal welfare problem in the herd with regard to this indicator, in case the value lies in the target range, i.e. the value is at least as good as the target value."
- "Alarm value: This value marks the threshold to the alarm range. In the alarm range, there is an animal welfare problem in the herd with regard to this indicator which urgently needs to be addressed according to the current state of knowledge." In the second round of the survey, the term "alarm value" replaced the term "limit value" originally used in the first round, to avoid misinterpretation in a legal or contractual sense.

The first round of the survey took place in February 2018. The values proposed by the experts from this round of the survey were subjected to a plausibility check. Any discrepancies (e.g. illogical relationships between the target and alarm values, obvious transcription errors) were clarified with the respective participants. Subsequently, descriptive statistics of the values were calculated and results submitted to the second survey round in July 2018. The participants received the anonymised aggregated results (minimum, maximum, mean, median) of the first round of the survey along with their personalised Excel® sheet with a new input option for each indicator next to their suggestion from the first round. Thus, they had the opportunity to review and, if necessary, adjust their initial suggestions in the light of the suggestions made by the group of experts. The statistical parameters (median, mean, 25th and 75th percentile) were calculated from the potentially modified target and alarm values submitted in the second round. The 25th and 75th percentiles were added to allow a clearer and more meaningful overview of the outcome. If participants did not add a value in the second round, the value from the first round was automatically included in the evaluation; participants had been made aware of this beforehand. After completion of the Delphi survey, the descriptive statistics on both survey rounds were sent to all participants in November 2018.

The Delphi survey was followed by the subsequent steps (EiKoTiGer-Projektkonsortium 2021, Schultheiss et al. 2023): A search of scientific literature (or currently unpublished prevalence studies, research and performance reports as well as unpublished field data studies) yielded information on common prevalences or incidences ("benchmarks") for the different animal welfare problems and any other threshold values (target, alarm values) already in use. Three expert panels were convened for cattle, pigs and poultry respectively, each consisting of approximately 25 experts from the scientific community, consultancies, veterinary bodies, administrations, farms as well as producer and animal welfare associations. Their task was to discuss the target and alarm values derived from the results of the Delphi survey and the literature search and reach a consensus in a final vote (consensus or majority vote).

The outcome was published as final proposal for the reference framework. The framework is intended as a source of support for livestock farmers for the identification of possible animal welfare problems on the basis of self-assessments. It does not aim to reflect the status quo of farming practice and is not intended for use in, for instance, official inspections.
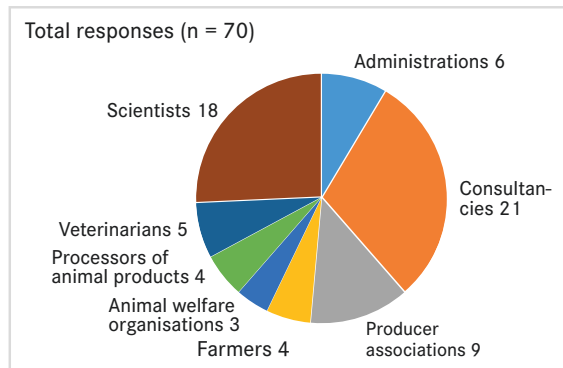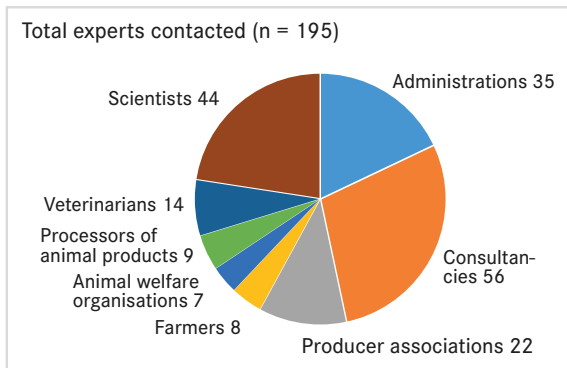
Results and discussion
Participation of the stakeholder groups in the Delphi survey
The Delphi survey response rates were 36% for cattle and for pigs and 19% for poultry (Figure 2). These rates can be considered satisfactory for a Delphi survey, especially for cattle and pigs, in view of the relatively large amount of time required to fill in the very complex survey questionnaire. Häder (2014) proposes a rate of about 30% as an expected reference value for response to Delphi surveys. The 19% response rate for poultry might be due to the comparatively large number of indicators for poultry and the complexity of the survey tables. In addition, some groups of stakeholders for poultry were fundamentally critical about the on-farm self-assessment system and, in particular, the creation of the refe¬rence framework and might therefore have deliberately opted not to participate.
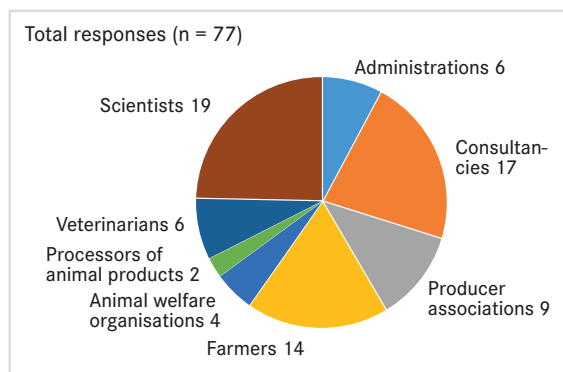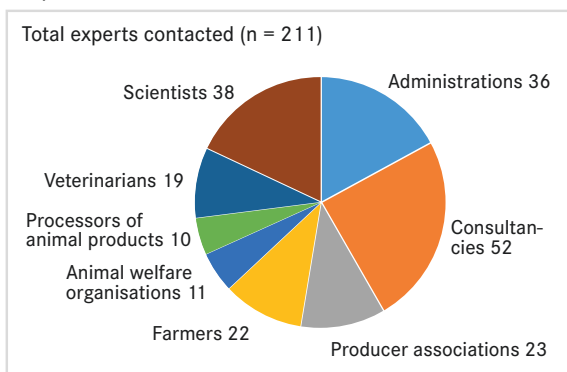
Cattle
Response rate: 36%

Total experts contacted (n = 195)

Scientists 44
Administrations 35
Veterinarians 14
Processors of animal products 9
Animal welfare organisations 7
Farmers 8
Producer associations 22
Consultancies 56

Total responses (n = 70)

Scientists 18
Administrations 6
Veterinarians 5
Processors of animal products 4
Animal welfare organisations 3
Farmers 4
Producer associations 9
Consultancies 21

Pigs
Response rate: 36%

Total experts contacted (n = 211)

Scientists 38
Administrations 36
Veterinarians 19
Processors of animal products 10
Animal welfare organisations 11
Farmers 22
Producer associations 23
Consultancies 52

Total responses (n = 77)

Scientists 19
Administrations 6
Veterinarians 6
Processors of animal products 2
Animal welfare organisations 4
Farmers 14
Producer associations 9
Consultancies 17

Poultry
Response rate: 19%

Total experts contacted (n = 161)

Scientists 28
Administrations 35
Veterinarians 12
Processors of animal products 13
Animal welfare organisations 9
Farmers 9
Producer associations 19
Consultancies 36

Total responses (n = 31)

Scientists 10
Administrations 5
Veterinarians 2
Animal welfare organisations 4
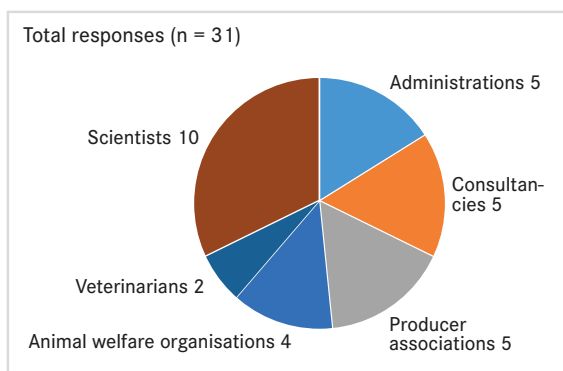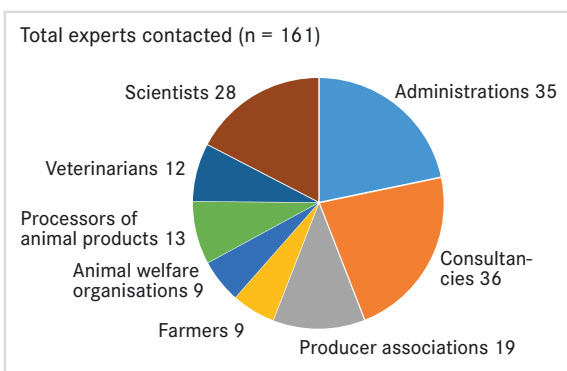Producer associations 5
Consultancies 5

Figure 2: Delphi survey: response rates for cattle, pigs and poultry based on the number of experts contacted from the different stakeholder groups (left) and the number of responses with suggestions for target and alarm values (right)

Of the consultants, 38% sent a response for cattle, 33% for pigs and 14% for poultry. The scientists' response rates were 41% for cattle, 50% for pigs and 36% for poultry. In the stakeholder group representing administrative bodies, only 17% reported back target and alarm values for cattle and for pigs and 14% for poultry.

Among the other experts who were contacted (veterinarians, livestock farmers, processors of animal products and animal welfare associations), the participation rates of livestock farmers varied noticeably. While the response rate was 64% for pig farmers and 50% for cattle farmers, the poultry farmers contacted (n = 9) reported no target and alarm values back.

Suggested target and alarm values for the animal protection indicators from the Delphi survey

The number of suggestions for reference values per indicator varied due to partial non-responses from up to 21 suggestions for poultry, up to 60 for cattle to 69 at maximum for pigs. The results of the 2018 Delphi survey for all indicators can be downloaded as Supplementary material 1-3 for cattle, pigs and poultry (three farming purposes per each species) at https://doi.org/10.15150/lt.2023.3294. Due to the large number of results, this paper will not discuss individual findings, i.e. the target value plus alarm value for a total of 207 individual indicators in addition to statistical parameters. However, all values for each of the indicators were discussed in detail in the expert panels described above for cattle, pigs and poultry with the about 25 experts each from the scientific community, consultancies, veterinary bodies, administrations, farms, producer and animal protection associations.

As the number of participants representing the individual stakeholder groups was low in some cases (ranging between 2 and 56 responses, Figure 2), it was not possible to perform a statistical analysis to identify differences between the suggestions submitted by the various stakeholder groups. Nevertheless, there were noticeable differences in the mean values. The representatives of animal protection associations often proposed the most stringent target values, followed by the "administration" group. In contrast, veterinarians, followed by consultants and representatives of producer associations proposed somewhat less restrictive target values; this might be because these stakeholders are more likely to suggest reference values that are easier to achieve in day-to-day farming conditions. In addition, some may assume that very ambitious reference values would negatively influence livestock farmers' motivation to initiate change – an insight gained from comments made on the reference values proposed in the survey. However, a closer look at the minimum and maximum values revealed that the suggested values were very heterogeneous within the groups in some cases. Variation within groups was often at least as high as between groups. Comparable findings were also reported by MARCH et al. (2017) based on a survey including scientists, consultants and practitioners. For these reasons, the decision was made to consider the average values of all responses as the result of the Delphi survey and to not analyse the results of the various groups of stakeholders separately.

Exemplary presentation of target and alarm values determined in the Delphi survey in relation to the final reference framework

Table 1 shows the results of the Delphi survey for some indicators as an example (second column). The results of the literature review, which followed the Delphi survey, can be found in the third column. The list of literature references for the prevalences shown in Table 1 can be downloaded as Supplementary material 4 at https://doi.org/10.15150/lt.2023.3294. In each case, they consist of the median of the prevalences determined in several field studies and the prevalences reported in the literature; the lowest and highest described prevalences are specified. The last column shows the final target and alarm values that were agreed on by the expert panels following discussions.

A complete list of all final agreed target and alarm values, the final reference frameworks, can be found for dairy cows, calves and beef cattle in Brinkmann et al. (2020b, c, d), for sows and suckling piglets or weaning piglets and fattening pigs in Schrader et al. (2020b, c) and for pullets/laying hens, broiler chickens and broiler turkeys in Knierim et al. (2020b, c, d). The methodology used to collect indicators was modified in some cases, and some indicators were deleted due to the results of the feasibility test carried out on farms. Furthermore, some results from the Delphi survey were summarised; hence, the type and number of indicators from the Delphi survey (Supplementary material 1-3) are not completely identical to the indicators in the final reference frameworks.

Table 1: Exemplary comparison of target values (TW) and alarm values (AW) from the Delphi survey with prevalences and incidences from field studies (according to the literature search) and the final reference values agreed in the expert panels

Animal welfare indicator	Delphi survey TW/AW (median)	Prevalences according to literature review[1] Median, minimum–maximum	Final reference values TW/AW
Indicators with high match „Delphi" versus „Final"			
Dairy cow: integument alterations (incl. swellings) wound or scab or substantial swelling on neck, carpal or tarsal joint (proportion animals,%))	≤ 4.0 / ≥ 10.0	7.1 1–81	≤ 4.0 / ≥ 10.0[2]
Dairy cow: clinically lame cows, i. e. slightly or severely lame (proportion of animals,%)	≤ 5.0 / ≥ 10.0	23.7 2.6–55	≤ 5.0 / ≥ 10.0[2]
Beef cattle: poor claw condition (proportion of animals,%)	≤ 5.0 / ≥ 10.0	2.7 0–33	≤ 5.0 / ≥ 10.0[2]
Sow: swelling on the legs (proportion of animals,%)	≤ 5.0 / ≥ 10.0	18.2 1.0–50.4	≤ 5.0 / ≥ 10.0[3]
Suckling piglet: animal losses - stillborn (proportion of animals,%)	≤ 5.0 / ≥ 10.0	8.5 4.5–9.7	≤ 5.0 / ≥ 10.0[3]
Weaning piglet/fattening pig tail injuries (proportion of animals,%)	≤ 2.0 / ≥ 10.0	3.6 0.1–47.0	≤ 2.0 / ≥ 10.0[3]
Laying hen: severe plumage damage (score 2, 35th week of life) (proportion of animals,%)	≤ 2.0 / ≥ 9.0	11.8 0.0–92.0	≤ 4.0 / ≥ 8.0[4]
Broiler chicken: severe footpad lesions (score 2, last week of life) (proportion of animals,%)	≤ 1.0 / ≥ 5.5	7.3 0.0–70.8	≤ 2.0 / ≥ 6.0[4]
Broiler turkey: total plumage damage (score 1 + 2) (proportion of animals,%)	≤ 2.5 / ≥ 6.5	0.0 0.0–4.7	≤ 4.0 / ≥ 8.0[4]
Indicators with deviations between „Delphi" and „Final"			
Dairy cow: dirty hindquarter (proportion of animals,%)	≤ 8.0 / ≥ 20.0	40 18–70	≤ 10.0 / ≥ 40.0[2]
Dairy cow: dirty lower hind leg (proportion of animals,%)	≤ 10.0 / ≥ 30.0	72 24–85	≤ 10.0 / ≥ 55.0[2]
Rearing calf: animal losses / mortality rate (from Day 7 up to and incl. 3rd month of live) (proportion of animals,%)	≤ 2.0 / ≥ 8.0	3 1–5	≤ 2.0 / ≥ 5.0[2]
Sow: stereotypies (proportion of animals,%)	≤ 3.0 / ≥ 10.0	22.0 8.0–34.0	≤ 5.0 / ≥ 15.0[3]
Suckling piglet: skin lesions on the carpal joints (proportion of litters,%)	≤ 5.0 / ≥ 10.0	56.3 14.0–98.3	≤ 5.0 / ≥ 15.0[3]

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Animal welfare indicator	Delphi survey	Prevalences according to literature review[1]	Final reference values
	TW/AW (median)	Median, minimum–maximum	TW/AW
Fattening pig: animal losses (proportion of animals,%)	≤ 2.0 / ≥ 5.0	2.7 1.8–5.9	≤ 1.5 / ≥ 3.0[3]
Laying hen: severe plumage damage (55th week of life, score 2) (proportion of animals,%)	≤ 2.0 / ≥ 9.0	35.6 0.0–100.0	≤ 4.0 / ≥ 44.0[4]
Laying hen: skin lesions (scores 1 + 2) (proportion of animals,%)	≤ 2.0 / ≥ 6.5	25.5 0.0–94.0	≤ 2.0 / ≥ 30.0[4]
Broiler turkey: total foot pad lesions (scores 1 + 2) (proportion of animals,%)	≤ 1.0 / ≥ 5.0	38.7 0.0–100.0	≤ 2.0 / ≥ 40.0[4]

[1] In addition to published data, previously unpublished data from various field data studies were also included.
[2] Brinkmann et al. (2020b, c, d).
[3] Schrader et al. (2020b, c).
[4] Knierim et al. (2020b, c, d).

The stakeholders in the expert panels for the different animal species adopted slightly different approaches in their discussions about the values from the Delphi survey and the "benchmarks" (prevalences or incidences identified in the literature search incl. field data from unpublished studies) and with regard to their agreement on the final target and alarm values (BRINKMANN et al. 2020b, 2020c, 2020d; SCHRADER et al. 2020b, 2020c; KNIERIM et al. 2020b, 2020c, 2020d).

After intensive discussions, for most of the indicators for cattle and pigs (see exemplary indicators, Table 1, upper half), the experts adopted reference values unchanged or with only minor modifications compared to the Delphi survey results. Thus, the latter were relatively well aligned with the "benchmarks". This means that about a third to quarter of the field data were in the alarm range, and the mean value of the prevalences or incidences fell often in the early warning range. Nevertheless, part of the data set was also in the target range, i.e. "in the green range" (Figure 1).

Based on the status quo found in practice, the early warning range was extended for a few of the indicators by raising the alarm value, e.g. dirty lower hind legs and hindquarter of dairy cows, stereotypies in sows as well as head and carpal joint injuries in suckling piglets (Table 1, lower half). In individual cases, however, it was extended because the method of collecting the indicator had been modified in the course of the procedure (e.g. for the indicator "injuries of teats and udders in sows", not listed in Table 1).

For a small number of indicators the expert panels agreed on lower, i.e. more stringent alarm values compared to the results of the Delphi survey (exemplary indicators, Table 1, lower half). For example, this applied to the share of excessively thin sows (BCS 1), animal losses in weaning piglets and fattening pigs, severe soiling with manure (sows, weaning piglets, fattening pigs) as well as severe skin lesions and severe lameness (weaning piglets and fattening pigs). In two cases, the target value was even lowered to 0% (for share of excessively thin sows and a clearly visible shoulder lesion in sows) because of their high welfare relevance and considering that only animals outside sick pens are to be included in the self-assessments. The adoption of more stringent final values for pigs and cattle compared to the Delphi survey was argued by experts to appropriately address specific serious animal welfare problems, such as severe lameness in dairy cows, calf animal losses or severe skin lesions in pigs, for which high prevalences or incidences have been reported in practice for a long time. The aim here was to prevent these unacceptable conditions from becoming customary and to raise awareness of the need to implement suitable improvement measures to reduce the number of often too high cases in practice.

After intensive discussions in the panels on poultry, the experts adopted only few reference values with no or minor modifications from the Delphi survey (Table 1, upper half), whereas a large number of the final published reference values deviated from the Delphi results. A challenge were those animal welfare indicators for which practice data predominantly fell in the "alarm range", i.e. the "red range" (Figure 1), which was often the case for poultry indicators. A hybrid approach was therefore adopted in the poultry panel discussions: On the one hand, the final target value was largely aligned with the results of the Delphi survey, notwithstanding partly controversial discussions. Thus, it was determined on a normative basis. On the other hand, the early warning range (Figure 1: the "yellow area" between target and alarm value), was significantly extended taking account of the status quo on farms. Mostly the alarm values corresponded to the median prevalences from the literature/field data. Therefore, these alarm values were not normative and not derived from the Delphi survey, but more strongly aligned with the "benchmarks", i.e. the prevalences reported in the literature/resulting from field data studies.

This was the case, for example, for foot pad lesions in fattening poultry (shown for broiler turkeys, Table 1 below) or for plumage damage in older laying hens (ibid.). With regard to the target values, the final reference values for various poultry indicators deviated slightly from the results of the Delphi survey due to the recommended sample size of 50 animals resulting in values graded in 2% steps (Table 1, exemplary indicators "broiler chicken: severe foot pad lesions (score 2, last week of life)" and "broiler turkey: total footpad lesions (scores 1 + 2)"). Minor adjustments were also made for logical reasons. For instance, the target values for all (severe and mild) lesions were set higher than for severe lesions only (Table 1: exemplary indicator "broiler turkey: total plumage damage (scores 1 + 2)"). There were some noticeable deviations from the described approach in the problem areas keel bone damages in laying hens and total foot pad lesions in turkeys in the fattening stage (broiler turkeys). In these cases, the normative target values from the Delphi survey of ≤ 3.0% and ≤ 4.3% were not considered realistic and were set at ≤ 10.0% and ≤ 30.0%, respectively.

The compromises adopted, in particular the consideration of the status quo concerning the poultry indicators, can be discussed controversially. On the one hand, the reference values based on the status quo may no longer fully meet the original purpose to distinguish whether there is an animal welfare problem with acute need for action or not. On the other hand, as a management tool, also improvements from a poor starting level should become apparent, and the reference values should help to motivate farmers to strive for better welfare. Moreover, existing differences between farms can become clearer.

A large range between target and alarm value in general transparently indicates fundamental problem areas in animal husbandry.

This approach is considered acceptable by the authors of this paper if, at the same time, all stakeholders step up their efforts to improve these animal welfare issues. The aim, at least in the medium term, must be to adjust the alarm levels to an acceptable level from an animal welfare point of view. At the same time, it should be noted that in many cases this will require far-reaching changes in the construction of livestock housing (e.g. quality of flooring) or in the organisation of work. Farmers can only realise such changes over a long period of time and with additional financial support. In any case, it underlines the need to regularly review the reference values for each animal welfare indicator. This would ensure that the reference values provide a consistent way of assessing the results of farm self-assessments in relation to the current status quo and society's expectations concerning animal welfare. New evidence may also require an adjustment of the reference values.

Conclusions

The assessment of animal welfare indicators by the farmer is important for the monitoring of animal welfare. It helps to analyse weaknesses and provides a basis for improving farm management. To assist livestock farmers in the evaluation of their livestock's welfare based on results from on-farm self-assessments, a reference framework with target and alarm values for animal welfare indicators is necessary. Such a framework was developed based on the multi-stage procedure described above. It shall help to identify risks on the farm at an early stage.

The participatory process of a Delphi survey and the subsequent discussions in expert panels involved relevant groups of stakeholders in the livestock farming sector. Particularly in the case of cattle and pigs, the target and alarm values resulting from the Delphi survey were largely in line with field data reported in the literature. However, in a number of cases, in particular for the poultry indicators, the reported field values were in the alarm range. For this reason, based on expert discussions, alarm values were raised. In contrast, in individual cases, alarm values for pig and cattle indicators were made more stringent for animal welfare reasons. In addition to the urgent need to address certain animal welfare problems affecting all livestock species and production types this indicates that the reference framework should be checked and, if necessary, revised after a few years or as soon as new evidence becomes available.

It would be desirable for the reference framework with target and alarm values to be used widely by farmers and veterinarians, as well as in training and extension.

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