LANDTECHNIK
AGRICULTURAL ENGINEERING

Indicators for on-farm self-assessment of animal welfare – Example: dairy cows

Rita Zapf, Ute Schultheiß, Werner Achilles, Lars Schrader, Ute Knierim, Hans-Joachim Herrmann, Jan Brinkmann, Christoph Winckler

The "on-farm self-assessment" specified by the Animal Welfare Act from 2014 requires the livestock keeper to assess and monitor appropriate animal-based measures ("animal welfare indicators") with the aim to achieve higher individual responsibility of livestock keepers for the well-being of their animals. The assessment serves to raise awareness among livestock keepers and to enable them to identify any weaknesses existing. As the Animal Welfare Act does not contain any secondary legislation, there has so far been a lack of more precise provisions regarding the content and scope of the self-assessment system. In order to identify appropriate indicators which address the most important animal welfare problems known from practice, around 50 experts have selected indicators for assessing animal welfare with regard to reliability, validity and practicability. In on-farm self-assessment, the sets of largely animal-based indicators selected for cattle, pigs and poultry (hens and turkeys) should be surveyed and evaluated as completely as possible. Integration into farm management systems is recommended. This paper exemplarily presents the set of indicators proposed for dairy cattle

In Germany, deficiencies as regards farm animal welfare have repeatedly been reported in recent years (WBA 2015). Despite compliance with the specified minimum requirements, conditions detrimental for animal welfare have been found. For instance, veterinarians have described considerable levels of technopathies, cannibalism induced integument damage, pathological alterations of organs, or behavioural abnormalities based on ante-mortem and meat assessments (BLAHA and RICHTER 2011). Livestock keepers themselves complain about excessively short productive life and high animal losses. Consumers are often confused by the discrepancy between farming reality and society's expectations regarding production methods. They increasingly take media reports on critical animal welfare states as a reason for questioning and rejecting modern livestock production systems as non-animal-friendly (KUNZMANN 2015). It is no longer acceptable to view the current conditions as "generally in line with animal welfare". Instead, it is morally imperative to reduce harmful conditions for animals and to strive for welfare improvements farm animals (KUNZMANN 2015).

Against this background an on-farm self-assessment was included in the Animal Welfare Act (§ 11 Abs. 8 Animal Welfare Act 2006) in 2013: "Any person keeping farm animals for commercial purposes must ensure through an on-farm self-assessment that the requirements of § 2 Animal Welfare Act are followed. In particular such persons must survey and assess suitable animal-based attributes (animal welfare indicators) for the purpose of assessing that the requirements of § 2 are satisfied."

The Scientific Advisory Council for agricultural policy at the Federal Ministry for Food and Agriculture (2015) considers the on-farm self-assessment an important tool for aligning societal expectations of livestock production and the situation on farm. However, so far there are no detailed specifications or provisions for the implementation of the on-farm self-assessment stipulated since 2014, as the Animal Welfare Act does not contain any secondary legislation to regulate the content, scope and frequency of the on-farm self-assessment. The animal welfare officers of the German Federal States are currently discussing suitable indicators and handling options; initial state-specific studies to set out suitable animal welfare indicators in more specific terms have already been completed, e. g. for pig farms in Baden-Württemberg (Karpeles and Richter 2015), or the keeping of turkeys in Lower Saxony (Andersson and Toppel 2014).

In animal welfare legislation as well as agricultural practice, mainly resource- and management-based animal welfare indicators have been used so far. These describe the conditions, e. g. the space available and the management, which are expected to safeguard animal welfare. However, such resource- and management-based indicators only allow indirect conclusions to be drawn on how well the animals may fare under these conditions. With the animal-based indicators required in the self-assessment system, on the other hand, the behaviour/health of the animals is recorded directly, so that direct conclusions about their well-being can be drawn (Deimel et al. 2010, Knierim 2010, DAFA 2012).

Experts from Germany and Austria have developed sets of largely animal-based indicators for routine on-farm self-assessment in dairy and beef cattle, rearing calves, sows, piglets and finishing pigs, turkeys and broilers, as well as pullets and laying hens. Using these indicators it should be possible to identify the most important animal welfare problems (Zapf et al. 2015). In the present paper, the set of indicators developed by the experts for dairy cattle is presented as an example. Additionally, methods for the assessment of these indicators are proposed and general recommendations for on-farm self-assessment made.

Material and methods

Selection of suitable indicators

In 2014 and 2015 two KTBL expert forums with cattle, pig or poultry experts from research and academia, consultancy, administration, animal welfare associations and practice took place, with approx. 16 experts per species. The experts were asked to select such indicators suitable for on-farm self-assessment from 23 indicator systems (KTBL 2014) that had previously been developed to evaluate animal welfare for different purposes.

For the selection, significant risks for health and behaviour were initially compiled from empirical data, for cattle, pigs and poultry. These are referred to below as "possible animal welfare problems". Indicators with which these possible animal welfare problems can be identified and which are sufficiently practicable, valid and reliable were then selected in three expert workshops for "Cattle", "Pigs" and "Poultry". Validity in this context is defined as the informative value of a parameter, in the meaning of "to what extent does the test instrument measure what it is meant to measure?" This makes it a gauge for the robustness of the conclusions based on the results of the measurement. Reliability is a measure for the precision of scientific measurements. When measurements are repeated under the same conditions, the same result ought to be obtained. To secure these requirements, the experts considered in particular indicators whose validity and reliability had been ascertained in

previous studies, e. g. within the framework of the Welfare Quality® project (2009) for cattle, pigs and poultry. Furthermore, it was taken into account whether the indicators cover the requirements set out in § 2 Animal Welfare Act:

- feeding in line with species and needs;
- care in line with species and needs;
- housing in accordance with behavioural needs;
- no causing of pain, avoidable suffering or harm due to restricted freedom of movement.

Assumptions for the selection

When selecting the indicators, the participants took the following – jointly agreed – aspects into account and based their consideration on the following assumptions:

- The indicators are to indicate to the livestock keeper whether the requirements in accordance with § 2 Animal Welfare Act are being observed. The primary goal is to raise awareness and strengthen the individual responsibility of the livestock keeper for a high level of animal welfare on their own farm.

- The on-farm self-assessment does not replace the daily routine inspections necessary to ensure good practice which the livestock keeper must conduct in accordance with § 4 Order on Animal Welfare and the Husbandry of Farm Animals (2006). It also does not cover any checking of compliance with resource- and management-based legal minimum standards.

- Animal-based indicators were included that allow conclusions to be drawn concerning animal health, as well as animal behaviour. However, for reasons of practicability animal behaviour is only recorded indirectly in some cases, e. g. on the basis of damage to the animal caused by behaviour (e.g. by feather pecking). In some cases,resource- and management-based indicators have been used if there were no suitable animal-based indicators.

- The indicators should be as simple as possible to survey and allow reliable statements to be made. The self-assessment system must entail a positive cost-benefit ratio for the livestock keeper and the efforts needed for survey and documentation must be minimised. For reasons of practicability, therefore, data already available on the farm, e. g. results of the official live animal assessment and the meat assessment ("Slaughterhouse findings") or data from the milk recording scheme (MLP), monitoring for antibiotics and the identification and information system for animals (HIT) were preferred.

- Conducting the self-assessment systems lies in the responsibility of the livestock keeper. However, he/she may delegate this task to a third party, e. g. consultant or veterinarian. The goal was to select indicators that expert livestock keepers can survey themselves, where appropriate after training.

- The indicators were selected with regard to their suitability as management aids and explicitly not with regard to their suitability as a monitoring instrument for law enforcement authorities.

Furthermore, initial suggestions regarding the assessment method, sample size, location, timing and frequency were developed for the selected indicators (ZAPF et al. 2015).

Results

Set of indicators for dairy cattle

The result of the expert consultations for dairy cattle comprises a list of largely animal-based indicators. However, for some animal welfare problems no suitable indicators according to the criteria set out above could be identified. This applies for example to the performance of species-typical movements that is often restricted in dairy cattle and beef cattle housing due to lack of space, or because of poor floor properties. Table 1 shows the indicators selected to record possible animal welfare problems in dairy cattle keeping.

Table 1: Indicators for the assessment of potential animal welfare problems – dairy cattle (Zapf et al. 2015)

Potential animal welfare problems	Indicator
Reduced productive life span	Productive life span (averaged over three years)
Mastitis	Somatic cell count (from MLP) Alternatively: mastitis treatment incidence [1]
Poor nutritional condition and metabolic disorders	Body condition score Fat-protein quotient of the milk
Lameness	Lameness prevalence
Alterations of the integument	Integument changes (including swellings)
Increased mortality	Animal losses (including animals lost through euthanasia)
Calving difficulties	Difficult birth rate
Inadequate water supply	Water availability (quantitative)
Low level of care (skin, claws)	Cleanliness of the animals Claw condition
Restricted resting comfort	Share of animals not lying completely on the resting area Rising behaviour
Human-animal relationship	Avoidance distance

[1] If no cell counts available from milk recording scheme.

Table 2 summarizes the expert opinion on the assessment methods for the recommended indicators for dairy cattle housing.

Table 2: Indicators and method proposals for the on-farm self-assessment – dairy cattle (Zapf et al. 2015)

Indicator	Proposed method	Proposed number/ sample	Recommended timing/frequency of survey and evaluation
Productive life span	Productive life span = average age of the cows disposed of (except sold for breeding purposes) minus the average age of these cows at first calving	Complete herd	Once per year
	Calculation as moving average over the last three years		
	Source: State board of the producer associations for animal improvement (LKV) or HIT		
Somatic cell count (from milk recording scheme)	a Share [%] of cows with somatic cell count < 100.000/ml	All milk-inspected cows	Once per year
	b Share [%] of cows with somatic cell count > 400.000/ml		Ideally evaluation of each LKV report
	c Share [%] of cows in first lactation with somatic cell count > 100.000/ml		
	Source: LKV		
Alternative[1]: Mastitis treatment incidence	Recording of each first treatment for mastitis	Complete herd	Once per year
	Counting of the treatment incidence on the basis of the medication administration and application records (AUA records); Tally list or corresponding herd management programme)		
	Renewed treatment after a seven-day break counts as first new treatment		
	Share [%] of treated animals per year		
	Source: Where appropriate State animal health program such as Pro Gesund/GMON or tally list		
Body condition	Simplified body condition score; overall evaluation with regard to subcutaneous fat layer in four body regions: tail head, lumbar region, transverse processes and protruding bones such as ischeal and hip bone tuberosity, ribs, spinous processes	Sample[2] based on herd size that considers all groups of lactating cows as well as dry cows in a herd proportionately	Twice per year In the middle of summer and winter
	Normal/too thin (at least three body regions too thin)/too fat (at least three body regions too fat)		
	Different categorisation criteria for dairy breeds and dual purpose breeds		
	Share [%] of too thin and too fat animals		
	Method and photos in accordance with Welfare Quality® (2009)		
Fat-protein quotient of the milk	a Share [%] of cows with fat-protein quotient > 1.5 in the milk (as indicator for suspected energy deficit situation in early lactation)	All cows in the first 100 days of lactation	Once a year ideally evaluation of each LKV report
	b Share [%] of cows with fat-protein quotient < 1.0 in the milk (as indicator of suspected rumen fermentation disorder)		
	Source: LKV		

Continuation of the table and footnotes on next page.

Indicator	Proposed method	Proposed number/ sample	Recommended timing/frequency of survey and evaluation
Lameness	Lameness scoring - In loose housing systems by gait scoring: 0: not lame 1: slightly lame (irregular timing of steps) 2: extremely lame (distinct reluctance to bear weight on one leg, or more than one leg affected) Share of slightly and extremely lame animals, respectively [%] - In tie stalls, signs of lameness when standing: 0: not lame 1: lame (repeated resting of a foot or stepping or placing of the front claw part on the edge of a step or bars of a manure grid or marked avoidance to bear weight during sideways movement; classification as lame if one of the three criteria is fulfilled) Share [%] of lame animals Method, aids (photos, films) in accordance with Welfare Quality[2)] (2009)	Sample[2)] based on herd size that takes all groups of lactating cows as well as dry cows in a herd into account proportionately	Twice per year In the middle of summer and winter
Integument-changes (including swellings)	Scoring from at most 2 m distance; examination of body regions carpal joint, tarsal joint, neck: Share [%] of animals with at least one lesion (scab, wound > 2 cm) or increased circumference/swelling (visible to the naked eye from a distance of at most 2 m) Method and photos in accordance with Welfare Quality[®] (2009)	Sample[2)] depending on herd size	Twice per year In the middle of summer and winter
Animal losses (including cases of euthanasia)	Share [%] of animals who have died due to euthanasia or emergency killing on the farm in the last 12 months Source: HIT	Complete dairy cattle herd	Once per year
Difficult birth rate	Share [%] of difficult calvings (Definition according to HIT: Caesarian or use of obstetrician or more than one person for assistance) out of all calvings in the last 12 months Source: HIT; data quality currently still unsatisfactory, recommendation: compulsory HIT entry	Complete dairy cattle herd	Once per year
Water supply	Assessment of the drinkers for functionality and sufficiently strong water flow (using bucket test for bowl drinkers > 10 l/min, for troughs > 20 l/min) Share [%] of drinkers with insufficient water inflow (nipple drinkers do not allow water uptake appropriate to the species and the flow is generally rated as insufficient)	All drinkers	Twice per year In the middle of summer and winter
Cleanliness of the animals	Assessment of the soiling (from a distance of at most 2 m, body side selected at random) in the body regions lower hind leg, upper hind leg, udder. 0: clean (no soiling or only single splashes) 1: soiled (three-dimensional plaques, altogether at least palm-sized accumulations of soil/ adhesions) Share [%] of animals with soiled lower hind leg Share [%] of animals with soiled upper hind leg Share [%] of animals with soiled udder Method, photos in accordance with Welfare Quality® (2009)	Random sample[2)] depending on herd size	Twice per year In the middle of summer and winter

Indicator	Proposed method	Proposed number/ sample	Recommended timing/frequency of survey and evaluation
Claw condition	Scoring of the claw condition of an animal from a distance of at most 2 m 0: no defects, claws intact 1: deficiencies on at least one claw. Criteria: too long or uneven height and length or incomplete ground contact or wall lesion or irregular wall surface Share [%] of animals with poor claw condition out of all lactating and dry cows	Random sample[2] depending on herd size	Twice per year In the middle of summer and winter
Share of animals not lying completely on the resting area	Share [%] of animals that are not lying (or not completely lying) on the resting area 3 h after feed provision, out of all animals[3]	All animals of a herd (kept under comparable conditions)	Twice per year In the middle of summer and winter
Rising behaviour	Scoring of the rising behaviour after either spontaneous rising events or after encouraging the cow to get up (e.g. by addressing the cow, touching her back) Share [%] of animals that do not rise fluidly (long pause on the carpal joints > 3 s and/or difficulties in rising or deviations from the normal movement sequence, e. g. horse-like rising horse-like) Method simplified after Chaplin und Munksgaard (2001)	Random sample of at least 10 cows per group or in groups with more than 100 cows 10 % of the animals	Twice per year In the middle of summer and winter
Avoidance distance	Avoidance distance at the feed bunk towards a person approaching (head-locking in the feed rack possible if carried out routinely) Observer approaches the cow at a uniform speed (1 step/s) from a distance of 2 m with arm stretched out forward and downward. If an avoidance reaction occurs, the distance between the hand and muzzle is estimated. If the hand touches the muzzle the distance is 0 cm. Shares [%] of animals in four classes: 0: 0 cm / 1: 1–50 cm / 2: 51–100 cm / 3: > 100 cm Method in accordance with Welfare Quality® (2009)	Random sample[2] depending on herd size	Twice per year In the middle of summer and winter

[1] Alternative to the somatic cell count, if no milk recording data are available.

[2] Herd size < 30 animals: assess all animals.
  Herd size 60 animals: 37 animals.
  Herd size 80 animals: 44 animals.
  Herd size 100 animals: 49 animals.
  Herd size 120 animals: 45 animals.
  Herd size 140 animals: 57 animals.
  Herd size 200 animals: 65 animals.
  Herd size 500 animals: 80 animals.
  Herd size 800 animals: 85 animals.
  Herd size 2000 animals: 91 animals.
  Herd size 3000 animals: 93 animals (according to WQ 2009).

[3] Indicator allows conclusions to be drawn regarding insufficient number, quality and dimensioning of resting places, possibly also concerning deficient feeding place situation (if animals are still feeding 3 h after feed presentation instead of lying on the resting place).

Expert recommendations

The livestock keeper should benefit from the on-farm self-assessment. To be able to use the results effectively for planning and implementing improvement measures, the single indicators should not just be assessed, but instead be integrated into more comprehensive management aids. The sets of indicators should therefore also be applied as a whole as far as possible, as with each missing indicator, the informative content is reduced and at the same time the risk increases that animal welfare problems are not recognised.

It is recommended that developers and providers of systems for on-farm self-assessment systems, e. g. farm evaluation systems and herd management programs, take the selected indicators into account. Possible software solutions should contain evaluation routines. In other words, it should be possible to manage and automatically evaluate the data. If possible, they should allow the integration of – yet to be established – reference values, or a comparison with other farms (benchmarking).

Data collection for the on-farm self-assessment system will be necessary at different times and at different frequencies (Table 2). It is already mandatory to survey some data (e. g. HIT data, use of antibiotics); however, their further evaluation and use is currently very heterogeneous. The indicators recommended for the self-assessment system partly imply that data currently not yet available on the farm be surveyed (e. g. the recording of integument damage, or abnormal behaviour in the barn). For each farm the time points for assessment and evaluation should be determined in such a way that these can be integrated efficiently into farm operations.

For the livestock keeper to be able to benefit from the results of the self-assessment, the outcomes should be recorded for longer-term comparisons. Changes over time can only be recognised or comparisons with similar farms (benchmarking) only be undertaken on the basis of such records.

It is recommended to train the livestock keepers in the use of the indicators, i. e. the on-farm assessment and evaluation. Involving an independent third person, e. g. a consultant or veterinarian, can also be helpful to counteract possible "blindness to one's own operations" and obtain inputs regarding appropriate intervention measures (BLAHA and RICHTER 2014). Alongside training opportunities for livestock keepers, it is recommended that the subject "on-farm self-assessment of animal welfare on one's own farm" be given more emphasis in vocational training curricula.

Conclusions

The on-farm self-assessment system supplements the daily routine inspection according to § 4 Order on Animal Welfare and the Husbandry of Farm Animals (2006) to ensure good professional practice. The livestock keeper is sensitised to questions of animal welfare by the on-farm self-assessment system in order to be able to comply with the individual responsibility for the animals. The on-farm self-assessment system supplies important information on whether animal welfare problems occur on the farm. The animal welfare indicators developed should therefore be surveyed systematically and evaluated regularly. Integration in more comprehensive management tools is advisable.

Currently there are no legal specifications concerning documentation of the results of the on-farm self-assessment system in accordance with § 11 Section 8 Animal Welfare Act. However, the experts recommend documentation on the farm so that these data can be evaluated e. g. via time series or benchmarking. One example here is the handling of performance data in producer association databases accessible online with which the farm manager can compare data – entered anonymously – with supra-regional performance parameters of comparable farms. The internal documentation can additionally serve the livestock keeper as evidence of implementing § 11 (8) Animal Welfare Act vis-à-vis the responsible authorities.

The experts have selected problem-oriented indicators so that the most important animal welfare problems may most likely be identified by the livestock keeper. In order to achieve the targeted goal of the self-assessment system – strengthening of individual responsibility of the livestock keeper regarding animal welfare – a user-friendly, easily understandable and at the same time informative tool

is necessary. The methods, including survey frequencies and sample sizes, are therefore going to be specified more precisely in guidelines for practitioners.

It furthermore will be necessary to develop target values and intervention threshold in terms of absolute values and benchmarks in order to enable the farmer to evaluate the results. The self-assessment system should reliably indicate if the requirements of § 2 Animal Welfare Act are not met and measures must therefore be taken to improve animal welfare on the farm. The present outcomes of the expert forums should be considered in further work conducted by farmers associations, research and academia, consultants and other stakeholders in animal production. This may for example include software providers of herd management systems, standardisation and provision of findings at slaughter, as well as the coordination of assessment and evaluation methods among scientists and consultants. Prior to a broad implementation of the self-assessment system, it is advisable to train livestock keepers regarding on-farm data collection and evaluation.

References

Andersson, R.; Toppel, K. (2014): Identifizierung und Erprobung von Parametern zur Indikatorbildung und als Instrument des Controllings - mit Fokus auf Mortalität, Fußballengesundheit, Arzneimitteleinsatz. Kurztitel: Puten-Controlling. Abschlussbericht vom 15.12.2014. 55 S. http://www.ml.niedersachsen.de/download/95254/Abschlussbericht_Puten-Controlling_.pdf, accessed on 3 July 2015

Blaha, T.; Richter, T. (2011): Tierschutz in der Nutztierhaltung. Analyse des Status quo und Lösungsansätze. Deutsches Tierärzteblatt 8, S. 1028–1038

Blaha, T.; Richter, T. (2014): Die besondere Verantwortung des Tierarztes für den Tierschutz. Am Beispiel der Nutztierhaltung. Deutsches Tierärzteblatt 1, S. 16–17

Chaplin, S.; Munksgaard, L. (2001): Evaluation of a simple method for assessment of rising behaviour in tethered dairy cows. Animal Science 72, pp. 191–197

DAFA, Deutsche Forschungsallianz (2012): Fachforum Nutztiere. Wissenschaft, Wirtschaft, Gesellschaft – gemeinsam für eine bessere Tierhaltung. Strategie der Deutschen Agrarforschungsallianz. http://www.dafa.de/fileadmin/dam_uploads/images/Fachforen/Brosch-DAFA-FFNutztiereWeb.pdf, accessed on 24 July 2015

Deimel, I.; Franz, A.; Frentrup, M.; von Meyer, M.; Spiller, A.; Theuvsen, L. (2010): Perspektiven für ein Europäisches Tierschutzlabel. BLE-Projektkennziffer 0 8 H S 0 1 0. Abschlussbericht, Universität Göttingen

Karpeles, M.; Richter, T. (2015): Konkretisierung tierbezogener Merkmale (Tierschutzindikatoren) nach § 11 (8) Tier-SchG für schweinehaltende Betriebe in Baden-Württemberg. Abschlussbericht, Institut für Angewandte Agrarforschung (IAAF) Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen

Knierim, U. (2010): Ansätze aus dem EU-Projekt Welfare Quality® zur Beurteilung des Wohlergehens landwirtschaftlicher Nutztiere. In: Aktuelle Probleme des Tierschutzes. 30. Fortbildungsveranstaltung der ATF-Fachgruppe Tierschutz des Institutes für Tierhygiene, Tierschutz und Nutztierethologie der Stiftung Tierärztliche Hochschule Hannover, 16.–17.9.2010, Hannover, S. 7–12

KTBL (2014): Tiergerechtheit bewerten. Sonderveröffentlichung, Darmstadt, KTBL e.V.

Kunzmann, P. (2015): Die moralische Rahmenhandlung. Geflügelhaltung in gewandelter Gesellschaft. In: ZDG/Damme, K., Muth, F. (Hrsg.), Geflügeljahrbuch 2016, Ulmer, Stuttgart, S. 33–37

TierSchNutztV (2006): Verordnung zum Schutz landwirtschaftlicher Nutztiere und anderer zur Erzeugung tierischer Produkte gehaltener Tiere bei ihrer Haltung (Tierschutz-Nutztierhaltungsverordnung). Fassung der Bekanntmachung vom 22. August 2006 (BGBl. I S. 2043), zuletzt geändert durch Artikel 1 der Verordnung vom 5. Februar 2014 (BGBl. I S. 94). http://www.gesetze-im-internet.de/tierschnutztv/BJNR275800001.html, accessed on 10 March 2015

TierSchG (2006): Tierschutzgesetz in der Fassung der Bekanntmachung vom 18. Mai 2006 (BGBl. I S. 1206, 1313), zuletzt geändert durch Artikel 3 des Gesetzes vom 28. Juli 2014 (BGBl. I S. 1308). http://www.gesetze-im-internet.de/tierschg/BJNR012770972.html, accessed on 10 March 2015

Welfare Quality® (2009): Welfare Quality® Assessment Protocol for Cattle. Welfare Quality® Consortium, Lelystad, Netherlands. http://www.welfarequalitynetwork.net/, accessed on 15 July 2015

WBA, Wissenschaftlicher Beirat für Agrarpolitik des BMEL (2015): Wege zu einer gesellschaftlich akzeptierten Nutztierhaltung. Kurzfassung des Gutachtens, http://www.bmel.de/Shared-Docs/Downloads/Ministerium/Beiraete/Agrarpolitik/GutachtenNutztierhaltung-Kurzfassung.pdf?__blob=publicationFile, accessed on 22 April 2015

Zapf, R.; Schultheiß, U.; Achilles, W.; Schrader, L.; Knierim, U; Herrmann, H.-J.; Brinkmann, J.; Winckler, C. (2015): Tierschutzindikatoren – Vorschläge für die betriebliche Eigenkontrolle. KTBL-Schrift 507, Darmstadt, KTBL e.V.

Authors

Rita Zapf, **Dr. Ute Schultheiß** and **Werner Achilles** are research assistants at the Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V., Bartningstraße 49, 64289 Darmstadt, e-mail: r.zapf@ktbl.de

Dr. Lars Schrader is head of the Institute of Animal Welfare and Animal Husbandry (ITT) at the Friedrich-Loeffler-Institut (FLI), Dörnbergstraße 25/27, 29223 Celle

Prof. Dr. Ute Knierim is head of the Department of Farm Animal Behaviour and Husbandry at the University of Kassel, Nordbahnhofstraße 1a, 37213 Witzenhausen

Dr. Hans-Joachim Herrmann is head of the Advisory Team Animal Husbandry at the Landesbetrieb Landwirtschaft Hessen (LLH), Schanzenfeldstraße 8, 35578 Wetzlar

Dr. Jan Brinkmann is senior scientist 'animal health and welfare' at the Thünen Institute of Organic Farming, Federal Research Institute for Rural Areas, Forestry and Fisheries, Trenthorst 32, 23847 Westerau

Prof. Dr. Christoph Winckler is head of the Division of Livestock Sciences at the University of Natural Resources and Life Sciences Vienna, Department of Sustainable Agricultural Systems, Gregor-Mendel-Straße 33, 1180 Wien, Austria

Acknowledgment