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A population-based on-farm evaluation protocol for comparing the welfare of pigs between farms

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Abstract

The variability of animal-based parameters was studied within a population of 41 farrow-to-finish farms. Data were collected during three visits, each corresponding to a different season within a two-year period. The largest between-farm variability was observed for stereotypic behaviour by pregnant sows, and for skin, ear and tail lesions, dirtiness and respiratory problems in growing pigs. Relationships with housing and management parameters were established to formulate advice on how to improve pigs' welfare.

Group-housed sows performed less oral stereotypic behaviour than individual housed sows (18.7 versus 44.1%), but a higher proportion of skin lesions was observed in group-housed sows (15.4 versus 2.0%). Prevalence of tail-biting behaviour varied between 0 and 21%. The risk for tail biting was higher in cases of reduced levels of floor space per pig, and ear-biting behaviour occurred more often when tails were docked short. Coughing was not correlated directly with the occurrence of lung lesions, but the risk was higher in instances of reduced space availability per pig. Farms could be ranked according to these welfare parameters, ie either according to the score of each individual parameter or based on the summation of all scores. Hence, welfare status was defined in relation to farm-specific information, allowing formulation of advice on housing and management to ultimately improve pig welfare through the matching of a predefined benchmark.

Keywords: *animal-based parameters, animal welfare, environment, housing, management, pig husbandry*

Introduction

Several protocols for farm animal welfare assessment at herd level are currently available (eg Bartussek 1999; Bracke *et al* 2004). These protocols are generally based on environmental and management characteristics, ie estimating a risk for impaired welfare (Capdeville & Veissier 2001). Vieuille-Thomas *et al* (1995) showed that the variability of welfare parameters can be higher within than between housing systems, indicating that design-based protocols, as such, are not completely valid to score animal welfare. The contribution from stockmanship seems to be very important, eg to reduce effects from aggression (Arey & Edwards 1998). Therefore, animal-based parameters are assumed to measure more concisely the actual welfare state of the animals (Whay *et al* 2003), but recording can often be time consuming. The interpretation and standardisation of the results can be difficult due to complex interactions between animal, housing, management and farmer (Sandøe *et al* 1997). Nevertheless, it is generally accepted that the most valid assessment of animal welfare is obtained when environmental and animal-based parameters are combined (Johnsen *et al* 2001), especially when the objective is to formulate advice for improvement. Consequently, a need exists to develop convenient methods for screening welfare on the farm as objectively and feasibly as possible.

Our objective, therefore, was to develop a tool to assess, on farm, the welfare status of pigs. The basic assumption was that the system should combine environmental and animal-based parameters and should be based on relatively simple measures that can be performed by a skilled assessor during one single visit. Although simple, such assessments must be comprehensive (Webster 2003). The investigated parameters were selected from the literature and, hence, considered valid measurements of pig welfare (Van Putten 1967; Geers *et al* 1989; Ödberg *et al* 1991; Thomas *et al* 1995; Arey & Edwards 1998; Bartussek 1999; Aarnink *et al* 2001; Hunter *et al* 2001; Leeb *et al* 2001; Schrøder-Petersen & Simonsen 2001; Vieuille-Widowski 2002; Moinard *et al* 2003). However, it is necessary to firstly quantify the existing variability within a defined population

Table 1 Overview of farm size relative to number of sows.

Mean number of sows	Number of farms
< 80	2
80–120	13
121–160	14
161–200	4
201–240	7
450	1
Total	41

of farms, so that the selected parameters will be representative of the characteristics of that population, including the inferred weighing factors for animal welfare. In this study both the housing conditions and herd management variables were recorded and animals were observed. This paper outlines the welfare assessment methodology that was developed and the main results.

Materials and methods

The farms

It was decided to investigate commercial pig farms, in order for the specific problems of on-farm evaluation to be experienced. Only farrow-to-finish farms were selected, so that all age categories could be monitored within a single visit. A list of farms representative of Belgian pig farms based on herd size, management practices and housing conditions, was provided by slaughterhouses and feed manufacturers. The final set of 41 such farms, including two organic farms, was based on the agreement of the farmers to participate and provide technical results.

Table 1 summarises the participating farms according to size; expressed by the number of sows.

Data collection

The choice of welfare parameters was determined by their relevance and the inferred or presumed degree of feasibility, validity and repeatability. The feasibility criterion can be particularly restrictive when assessing welfare on a farm. The often-limited time available and the potential practical difficulties of data collection preclude the measurement of many behavioural parameters (Spoolder *et al* 2003).

The data were collected during three visits on each farm within three different seasons over two years, ie June to December in 2003, January to March and July to September in 2004. A farmers' questionnaire was completed and the animals were observed during each visit.

Resources, management and technical results

By means of a questionnaire general information was collected on management, infrastructure, feeding, production results, mortality and use of veterinary medicines. Specific information relating to housing conditions was observed directly for all categories of pigs (sows, growers, fatteners): pen and compartment size, stocking density, access to manipulative material, number and kind of feeding spaces and of drinking nipples, floor type, light and ventilation type.

Animal observations

During the first visit a total of 2,346 pregnant sows were monitored, with 2,804 and 2,575 monitored for the second and third, respectively. Data were collected during one farm visit from 65 gestating sows, one room of growing pigs (live weight 30 to 40 kg) and one room of fattening pigs (live weight 80 to 100 kg). A room typically contained between 12 and 24 pens. The observations (Table 2) were repeated in the same or in an identical compartment during subsequent visits; hence, important within-farm variations in housing or in management were taken into account. It was decided that two well-trained scientists should collect a specific component of the data in order to avoid bias arising through inter-observer variability. Training was based on the expertise within participating institutes through the use of multimedia material as a template and practicing on a test farm. These persons carried out the observations in two phases during each visit. Firstly, all behavioural characteristics were recorded for 5 min for each pen while the pigs were aware of the observer's presence: ie approach latency for three pigs to come within reaching distance from the person standing in the entrance of the pen (specific test for growing pigs), the number of animals that sneezed, coughed, rubbed, took another pig's tail or ear in its mouth, that showed oral stereotypies (specific for sows) or other abnormal behaviours, that were aggressive or that showed playing behaviour. The result was expressed as the number of animals showing a behaviour divided by the total number of animals being observed.

In the second phase all pigs within the selected room were individually scored for dirtiness, lameness, scratches, abscesses and other wounds, the occurrence of ear necroses, bitten tails or bitten ears. These observations were standardised and categorised by making use of templates being defined in a preliminary investigation and taking into account prevalence and severity. The mean value of each categorised (cat) variable per farm was calculated as:

(number of pigs in Cat 0) × 0 + (number of pigs in Cat 1) × 1 + (number of pigs Cat 2) × 2 + …) divided by the total number of observed pigs.

Scratching was scored by taking into account the number, severity and distribution of scratches over the body (Leeb *et al* 2001). Animals in category 0 had no scratches, in category 1, superficial scratches on less than one third of the body surface and, in category 2, the skin was penetrated over more than one third of the body surface.

Tail and ear biting were evaluated according to four categories based on the distribution of the population: category 0, no lesions; category 1, slightly damaged; category 2, severely damaged; category 3, almost eaten.

Pigs were divided into three categories for dirtiness: category 0, clean; category 1, less than half of the body surface is slightly dirty; category 2, more than half of the body is severely dirty.

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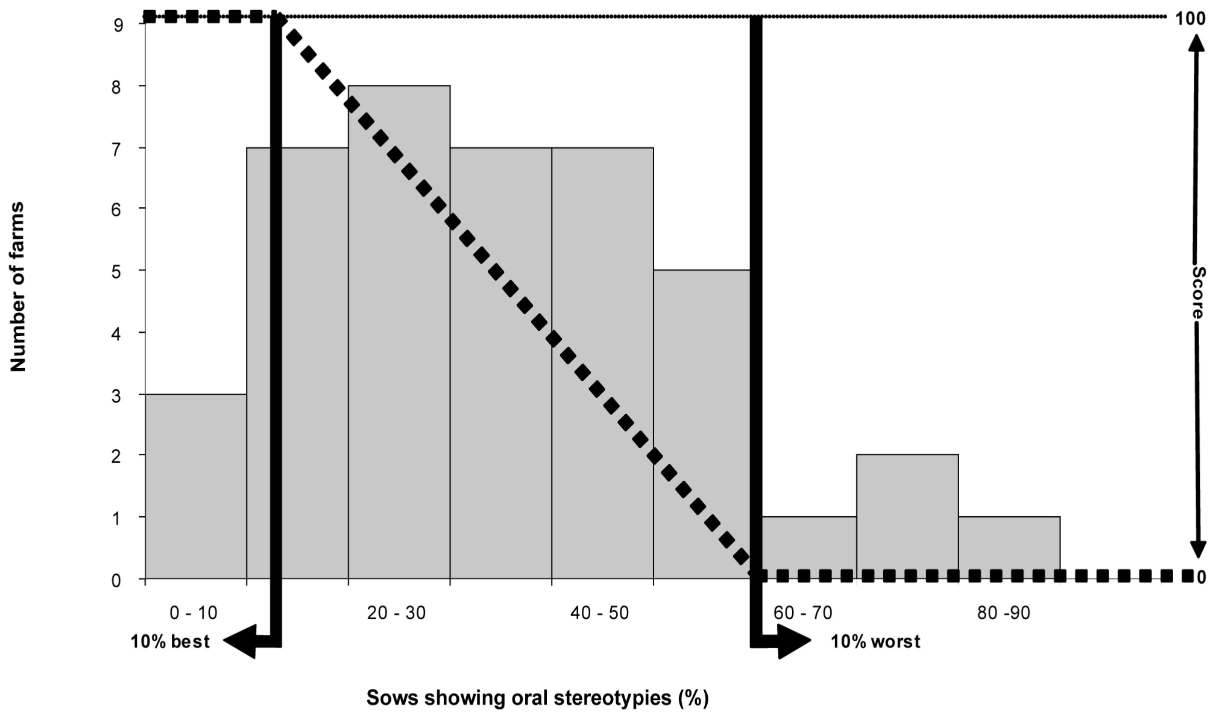
Table 2 Animal-based parameters for each category of pig.

	Pregnant sows	Growers	Fatteners
Behaviour	Aggression Oral stereotypies Rubbing	Aggression Tail biting Ear biting Approach-avoidance Rubbing	Aggression Tail biting Ear biting Approach-avoidance Rubbing
Body	Scratches Abscesses Wounds Dirtiness Condition	Scratches Ear Tail Wounds Dirtiness	Scratches Ear Tail Wounds Dirtiness
Health	Lameness	Coughing Sneezing	Coughing Sneezing Lung lesions

Figure 1



Method to define benchmarks: (1) make the histogram of a welfare parameter (eg oral stereotypies), (2) infer the 10% best and 10% worst cases, respectively set at score = 100 and score = 0, and (3) define 4 to 5 categories between 0 and 100.

Lesions of heart, lungs and liver from post mortem inspection were made available by the slaughterhouses to assess the pigs' health status. These results were expressed as the number of animals with lesions (pleuritis, pneumonia, pericarditis) divided by the total number of animals within a batch.

Data analysis

Descriptive statistics were calculated using the statistical software package SPSS 11.0. The data collected during the three visits were analysed as replicates, because it was assumed that between two visits the population of pigs had changed. Most parameters did not show a normal distribution and therefore the non-parametric Mann-Whitney *U* test was used to compare mean values between selected groups of data. These groups of data were created by defining class variables, eg individual, compared to group housing of sows. Multivariable analyses were not performed, because it was found that farms differed too greatly and interactions too complex to be quantified, as each definable category had too few replicates. Hence, weighing factors for the investigated parameters were not calculated.

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Table 3 Descriptive statistics (in percentages of animals) of selected animal-based parameters.

Category of pig	Parameter	Minimum	Median	Maximum	Mean	SD
Sows	Stereotypies	0	32.2	96.8	34.0	20.1
	Dirtiness	5.2	17.1	84.8	22.3	16.1
	Scratches	0	17.6	30.9	15.4	9.8
Growers	Dirtiness	0.4	7.4	58.1	11.9	12.1
	Scratches	0.8	7.1	23.8	8.3	6.3
	Tail lesions	0	2.6	16.4	3.7	3.8
	Ear lesions	0.4	8.6	39.7	12.5	9.9
Fatteners	Dirtiness	3.2	12.8	60.2	16.9	11.9
	Scratches	0.4	3.3	19.6	3.9	3.6
	Tail lesions	0	1.6	15.2	2.4	2.8
	Tail biting	0.9	5.6	17.8	6.8	3.7
	Ear lesions	0	3.5	28.7	5.6	6.6
	Ear biting	0.3	2.0	5.7	2.4	1.4
	Coughing	0	2.1	18.3	2.8	3.0
	Liver lesions	0	3.4	23.3	5.4	6.0
	Pleuritis	0	3.7	35.4	6.4	8.4
	Pneumonia	0	3.9	21.5	4.6	4.0
	Pericarditis	0	2.9	11.2	3.2	2.1

Table 4 Benchmarking model of farms for oral stereotypies (% sows) and mean scratch value.

Score	Oral stereotypies	Scratches
100	< 12	< 1.10
75	12–27	1.10–1.20
50	28–43	1.21–1.30
25	44–59	1.31–1.40
0	≥ 60	≥ 1.40

Benchmarking system

In order to compare farms' scores on each parameter ie benchmarking, two steps were followed. Firstly, the descriptive statistics of the population were calculated for each parameter and, secondly, the following reference points were defined for each parameter on the histogram of the population: the mean of the best 10% and the mean of the worst 10% scoring farms were set at the maximum score of 100 and the minimum score of 0, respectively. A linear regression was calculated between both points, as the reference line for defining categories from very good to very bad on an equally divided three-to-five point scale depending on the variance of a specific variable (Figure 1).

Results

Variability within body condition, lameness, abscesses, wounds, and behaviour other than stereotypies and tail biting was too low to allow the calculation of a calibration line. Therefore these parameters were omitted from further analyses.

Gestating sows

Housing parameters

The gestating sows were tethered in 4 farms and group-housed in 11. Of the remaining 26 farms, they were housed in individual boxes with partially-slatted floors. Only two farms, being organic, provided straw. On three farms (one of which being organic) an outdoor run was available. Ventilation tended to be based on natural convection and a heating system was not installed.

Animal-based observations

The minimum and maximum occurrence of the observed behaviours and lesions are shown in Table 3. The observed values of the parameters had a wide range, indicating important differences between farms.

Oral stereotypies in group housing (19 ± 20%) were less prominent ($P < 0.001$) than in individual housing (44 ± 20%). Sows were restricted fed in both housing systems, but the time of feeding could not be taken into account. The variability between farms allowed implementation of a linear scoring system (Figure 1), which can be translated into a benchmarking model (Table 4). Individually-housed sows had significantly less scratches than those group housed, ie 2.0 ± 2.0% versus 15.4 ± 9.8% ($P < 0.05$). The benchmarking model is shown in Table 4.

Growing and fattening pigs

Housing parameters

The median values for conventional housing conditions in growers were: a pen with 100% slatted floors (concrete, plastic, metal), 13 pigs per pen and 0.4 m^2 floor space per pig, one drinking nipple and 4 growing pigs per feeding place. In most pig rooms, there was mechanical ventilation and a volume per pig of 1.1 m^3. There was a light permeable area making up only 0.6% of the floor area, so it was dark for the majority of the time. In 36% of the farms the floor was partially slatted and 36% of the farms provided the pen with a chain as manipulative material. Other materials were not observed. Ten percent of the farms kept pigs in large groups of between 50 and 300.

The fattening pigs were not kept in large groups. Median values were 12 pigs per pen with 0.7 m^2 floor space per pig,

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Table 5 Benchmarking model of farms for tail and ear-biting behaviour (% growing pigs) and mean dirtiness value.

Score	Tail-biting behaviour	Ear-biting behaviour	Dirtiness
100	< 2.8	< 1.0	< 1.04
75	2.8–6.9	1–3.3	1.04–1.16
50	7.0–11	3.4–5.6	1.17–1.28
25	12–15	5.7–7.9	1.29–1.40
0	≥ 15	≥ 7.9	≥ 1.40

Table 6 Benchmarking model of farms for pleuritis, pericarditis and pneumonia (% slaughter pigs).

Score	Pleuritis (%)	Pericarditis (%)	Pneumonia (%)
100	< 6.5	< 2.6	< 3.3
50	6.6–13	2.7–4.3	3.4–6.6
0	≥ 13	≥ 4.3	≥ 6.6

100% concrete-slatted floors (gap width 2 cm and slats 10 cm), one drinking nipple and 3 pigs per feeding space. In the compartment there was a volume per pig of 2.4 m^3. Thirty-three percent of the farms provided manipulative material to the pigs by means of a chain.

Animal-based observations

The percentage of growing pigs showing tail-biting behaviour varied between 0 and 22.4% of the observed pigs on a farm (median 9.6%). For the fattening pigs, the occurrence of tail-biting behaviour varied between 0 and 21.4% (median 6.3%). The percentage of pigs with tail lesions is shown in Table 3. All conventional farms applied tail docking as common practice and two categories are distinguishable: half cut or almost completely cut. In this context it is also remarkable that on those farms on which tails were more often docked more shortly there was greater occurrence of ear-biting behaviour (ie 0.11 versus 0.01%; $P < 0.005$) and hence more ear-biting wounds. Table 5 shows the inferred benchmarking model for tail and ear biting behaviour.

The growing and fattening pigs were housed in barren conditions. Provision of manipulative material should, in theory, reduce the occurrence of ear and tail biting but on the 14 farms in which the manipulative material was restricted to the presence of a chain, we found no such effect on the occurrence of ear and tail biting behaviour or on lesions of this nature. Growing pigs housed with a stocking density of less than 0.31 m^2 per animal had more lesions, ie 0.17 versus 0.07% ($P < 0.01$).

The overall score for dirtiness for pregnant sows, growers and fattening pigs is shown in Table 3, and the benchmarking model in Table 5, combining percentage of animals with degree of cleanliness.

Health parameters

Coughing was not observed in pregnant sows, but more fattening pigs were coughing when the volume of the pig house was less than 3.5 m^3 per pig, ie 1.9 versus 1.3% ($P < 0.05$). The frequency of lung lesions (pleuritis, pneumonia) was higher than for coughing (Table 3) showing the relevance of post mortem investigation into the slaughter line or the inadequacy of 'cough' screening. The inferred benchmarking model is shown in Table 6.

Discussion, conclusions and animal welfare implications

The objective of this study was to establish a methodology for comparing pig farms based on a selection of animal welfare-related parameters. However, variability within certain parameters, ie body condition, lameness, abscesses and wounds, was too low to allow selection, while the observation of behaviour other than stereotypies and tail biting was difficult to standardise, interfering with a straightforward interpretation. Thus, these parameters were omitted from further analyses. This comparison did not evaluate the integrated level of welfare for an individual pig, nor were thresholds defined to decide upon good or bad welfare. Nevertheless it was possible to rank farms from good to bad in relation to a selected set of welfare-related parameters. Moreover, the application of tools for on-farm assessment of animal welfare should also provide information to allow the farmer to improve management and housing conditions (Sorensen *et al* 2001). Therefore, the parameters used should not only be relevant in terms of animal welfare, but also easily repeatable and applicable at the farm level (Spoolder *et al* 2003). Most of the selected parameters in the present study showed high variability between farms in terms of housing and management resources, allowing a) a categorised comparison of farms based on relevant animal-based parameters (benchmarking) and, b) formulation of advice on how to improve pigs' welfare, based on the integration of animal-based, resource-based and management-based information. As farmers are able to compare their results and standing within the population, they are strongly motivated to implement improvements. Moreover, decision-makers are able to direct improvements by differential rewarding of farms depending on their objective ranking order instead of via an abstract statement to evaluate animal welfare.

Housing systems have an important influence on the behaviour of gestating sows and differences seen in group and individual housing were found to be in accordance with Vieuille-Thomas *et al* (1995). Stereotypic behaviour of pregnant sows is explained by the application of restricted feeding (Robert *et al* 1997; Meunier-Salaün *et al* 2001). Ideally, the method of recording stereotypic behaviour should refer also to the moment of observation in relation to the feeding period, including pre- and post-feeding behaviour. Ödberg *et al* (1991) found more stereotypies in sows prior to feeding while Rushen (1985) found certain stereotypies were performed during the delivery of food and others immediately after feeding. Such differences are probably linked to meal size (Terlouw *et al* 1991, 1993). However, it is not always feasible to collect this information when farm visits do not match eating time. Moreover, stereotypic behaviour is a multifactorial problem (Mason & Mendl 1997). Indeed, group housing of sows is reported to reduce, substantially, the frequency of stereotypies indicating that living in a group can partially compensate for the effect of restricted feeding. This may be due to group housing providing a more enriched environment and allowing sows to pursue the maintenance of social rank which, in the case of stable groups, results in more rest. However, the maintenance of social hierarchy has been shown to result in more scratches (Jensen & Wood-Gush 1984); a similar result can be seen with increased competition for food (Leeb *et al* 2001).

In the case of growing pigs, tail and ear lesions are a greater problem than scratches. Tail biting is an abnormal behaviour, characterised by one pig's dental manipulation of another pig's tail and represents one of the most important welfare-reducing problems in modern pig production (Schrøder-Petersen & Simonsen 2001; Bracke *et al* 2004). Tail injuries will affect the victim's welfare, not only because the wound is painful, but also because infection can spread to various organs. Tail lesions can also result in abscesses that are very painful (Moinard *et al* 2003). The welfare of the pigs that bite could also be reduced as it may be a redirected movement due to the absence of adequate substrates. This frustration may lead to excessive motivation towards biting the tails of pen mates (van Putten 1967; Schrøder-Petersen & Simonsen 2001). This malignant behaviour is also related to disturbed foraging behaviour (Wood-Gush & Vestergaard 1989). Correlations with stocking density and the length of docked tails were also observed, but as outbreaks of tail biting are rather unpredictable (Widowski 2002) this is hard to demonstrate. The case for the docking tails giving a reduction in the occurrence of bitten tails (Hunter *et al* 2001) could not be confirmed, but a negative correlation with ear biting was found. Providing chains did not substantially reduce tail biting, because pigs have a tendency to lose interest in these novel objects fairly quickly after having become accustomed to them. This is particularly true when no positive reinforcement is attached to the object, and in such cases the preventive effect may be limited (Schrøder-Petersen & Simonsen 2001). Therefore, items such as the Edinburgh Foodball® (Patent No 9200499.3), which delivers a pellet immediately and once again when rooted, should be more efficient as foraging is rewarded according to a variable ratio-conditioning programme (Young *et al* 1994).

In observing tail or ear biting behaviour it was impossible to make a distinction between merely taking the tail or ear in the mouth and actual dental manipulation of either, except when a reaction indicating pain was observed. Nevertheless, the population parameters for tail-biting behaviour and tail lesions were matching quite well for fatteners, which was not the case for ear-biting behaviour and ear lesions. These results might indicate that the observation of tail-biting behaviour can be substituted by the observation of tail lesions, while ear-biting behaviour is not representative of the prevalence of ear lesions. However, in order to exclude a confounding effect of subsequent phases of tail-biting behaviour and the prevalence of tail lesions, further research should focus on improving the standardised distinction between both elements of tail-biting behaviour, ie taking the tail in the mouth or actual dental manipulation. Such an approach within a cohort study over time can infer a straightforward interpretation of whether or not tail-biting behaviour, in its premature phase, has a predictive value for dental manipulation of the tail resulting in tail lesions.

Another animal-based parameter is cleanliness as it relates to ambient temperature (Aarnink *et al* 2001), effective temperature control (Geers *et al* 1986, 1989) and social stability (Hacker *et al* 1994). An appropriate indicator of housing condition is the prevalence of respiratory disease (Cleveland-Nielsen *et al* 2002). Observation of coughing frequency and post mortem investigation of the respiratory system are found to be useful in the ranking of farms. An increased susceptibility to disease is considered a result of impaired welfare affecting the immune system (Broom & Corke 2002).

Approach tests were developed to evaluate humane handling of pigs (Hemsworth *et al* 1993), but the present study could not show a consistent variability allowing it to be used as a scoring tool for ranking farms. Nevertheless, the present study has demonstrated that certain animal-based parameters differ substantially between farms, being specific for a well-defined population of farms. The definition of the scoring system is based on the distribution of the population for each parameter. Hence, each farmer is able to compare his/her results with the specific distribution of the population. Another advantage is easy upgrading by introduction of newly collected data.

This study contributed to an improvement in pig welfare at different levels: 1) it showed the methodology to transform variability at population level within animal-based welfare parameters into a ranking system for comparing pig farms with regards to various animal-based welfare parameters (the prevalence of stereotypic behaviour, scratches, tail and ear wounds, lung lesions and cleanliness) (Tables 4–6); 2) the methodology for developing the tool is generally applicable for all well-defined populations of farms, and 3) it is possible to rank farms, ie according either to the score of each individual parameter or based on the summation of all scores. Hence, pig welfare status is defined in relation to farm specific information, allowing the formulation of advice on housing and management to improve welfare, and even to define targets for improvement. Further research on other populations of farms is necessary to prove the repeatability and feasibility of the methodology as a protocol for on-farm comparison of the welfare of pigs.

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