

# ANIMAL-BASED MEASURES FOR THE ASSESSMENT OF WELFARE STATE OF DAIRY CATTLE, PIGS AND LAYING HENS: CONSENSUS OF EXPERT OPINION

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## Abstract

*Animal Welfare* 2003, 12: 205-217

*A Delphi technique was used to gather the opinions of animal welfare experts on the most appropriate measures for welfare assessment of farm animals. The experts were asked to consider measures that were directed towards the animal (animal-based), rather than measurement of their environment. This systematic approach was designed to achieve a degree of consensus of opinion between a large number of experts. Two rounds of postal questionnaires were targeted at people with expertise in one or more of the species of interest. The respondents suggested measures based upon observations of health status, behaviour, and examination of records. These measures reflect the animal's welfare state — in other words, how the animal is coping within the environment and husbandry system in which it lives. The measures for cattle, pigs and laying hens were categorised into 22, 23 and 28 aspects, respectively, with the highest ranking of importance being given to observation of lameness in dairy cattle and pigs and to observation of feather condition in laying hens. This Delphi study was the basis for the development of a series of protocols to assess the welfare state of dairy cattle, pigs and laying hens.*

**Keywords:** *animal-based welfare measures, dairy cattle, Delphi technique, laying hens, pigs, welfare state*

## Introduction

Traditionally, farm animal welfare assessment has centred on measurement of the resources supplied to the animal. A well-recognised resource-based protocol has been used to assess the welfare of animals on Austrian farms (Bartussek 1999). This assessment method applies a weighting to each resource, and the sum of these produces a single score. However, the provision of good management and environmental resources does not guarantee that an animal is healthy and fit and that it has a high standard of welfare. For the purposes of this paper, an animal's welfare state is defined as how well that animal is able to survive and remain fit within the particular constraints of the husbandry system in which it lives. In this paper, therefore, we aim to determine animal-based measures of animal welfare that reflect the effect of the husbandry conditions on the animal.

A husbandry or resource-based assessment could include measures of the stockman, environmental and animal factors that affect the welfare of the animal, such as stockman

competency and handling skills, environmental provision of suitable housing and diet and appropriate genetic suitability of animals to the management system. UK Farm Assurance Schemes operate membership criteria that require compliance with predominantly resource-based standards (Wood *et al* 1998). In a study of rates of failure to comply with the Farm Assured British Pigs schemes standards, Main and Green (2000) found that out of a total of 249 welfare-related compliance failures, only 8% were associated with issues of welfare state such as health. The remaining instances of welfare non-compliance concerned deficits in physical resources (85.6%) and stockmanship (6.4%).

The use of physical resources as a measure of welfare is attractive because these tend to remain constant and can be measured objectively. Many interacting resources affect the welfare state of an animal; however, it can be difficult to correlate resources and the actual welfare state with any degree of certainty. Many animal-based measures are currently used, most frequently as tools to assess one specific welfare issue at a time. Examples include plumage scoring in hens (Freire *et al* 1999), skin lesion scoring in pigs (Mouttotou *et al* 1999; Leeb *et al* 2001) and locomotion and lameness scoring in cattle (Whay & Main 1999).

To develop a protocol for the assessment of welfare state, a Delphi technique was used (Linstone & Turoff 1975). The Delphi process begins with a consultation document that is sent to an expert panel to gather a broad base of knowledge and/or opinion. All of the information from this consultation is summarised and then returned to the expert panel in order to allow all panel members to comment on or rank the views of all the other panel members. In this way, a consensus of opinion is reached. This consultation technique has been used frequently in human-health-related research (Hutchinson & Fowler 1992). The technique is an iterative process designed to achieve consensus on subjective judgements. The Delphi technique does not require experts to meet and so minimises the problems associated with large group meetings such as cost, practical coordination of members and problems with adverse interpersonal relationships.

The objective of this study was to identify outcome measures for the welfare state of dairy cattle, pigs and laying hens (free range) through a consensus of expert opinion. These measures were then to be used to develop welfare-assessment protocols for on-farm studies to evaluate the welfare state of these species.

## **Methods**

A questionnaire was developed, the aim of which was to establish potential measures suitable for assessing welfare through animal-based assessment. The questionnaire is shown in Figure 1. The questionnaire was designed to encourage each respondent to identify five issues (eg lameness in dairy cattle) that they considered affected the welfare state of the species in which they had particular expertise. Having identified these issues, the respondent was then asked to list up to three animal-based measures for each issue identified.

### ***Expert panel members***

A total of 154 experts was drawn from one or more membership lists of the British Society of Animal Science (28), the International Society of Applied Ethology (12), the Animal Welfare Science, Ethics and Law Veterinary Association (AWSELVA) (51), technical committees of the Royal Society for the Prevention of Cruelty to Animals (RSPCA) (23) and the attendance list of the International Workshop into the Assessment of Animal Welfare (Copenhagen, August 1999; 45). Ninety-nine experts who received the questionnaire either had no known

Species	Laying hen <input type="checkbox"/>	Pig <input type="checkbox"/>	Dairy cattle <input type="checkbox"/>
1. Welfare criterion / issue that should be assessed			
<i>Comments:</i>			
2. How important to the individual animal is this aspect of welfare? (0=minimum score, 5=maximum score)			
Score:                    0        1        2        3        4        5			
<i>Comments:</i>			
3. How important to the UK herd / flock is this aspect of welfare? (0=minimum score, 5=maximum score)			
Score:                    0        1        2        3        4        5			
<i>Comments:</i>			
4. (For negative welfare issues only) to what extent can the issue be avoided by good husbandry practice? (0=unavoidable)			
Score:                    0        1        2        3        4        5			
<i>Comments:</i>			
5. What measure(s) do you think are useful indicators of this welfare criterion / issue? Please give brief methodological details of this measure	6. In your opinion, how good an indication of this criterion is this measure? (0=minimum score, 5=maximum score)	7. In your opinion, how practical is this measure during a half-day visit? (0=minimum score, 5=maximum score)	
Measure:	Score: 0   1   2   3   4   5	Score: 0   1   2   3   4   5	
<b>Brief details:</b> Reference (if available):	<i>Comments:</i>	<i>Comments:</i>	
<i>Comments:</i>			
Measure:	Score: 0   1   2   3   4   5	Score: 0   1   2   3   4   5	
<b>Brief details:</b> Reference (if available):	<i>Comments:</i>	<i>Comments:</i>	
<i>Comments:</i>			
Measure:	Score: 0   1   2   3   4   5	Score: 0   1   2   3   4   5	
<b>Brief details:</b> Reference (if available):	<i>Comments:</i>	<i>Comments:</i>	
<i>Comments:</i>			

**Figure 1**        **The questionnaire sent to all members of the expert panel. Five copies of the questionnaire were made available to each panel member to encourage identification of five issues affecting welfare state and three sets of associated animal-based measures.**

species preference or were believed to have an interest in more than one species. The remaining experts were known to have expertise in dairy cattle, pigs or laying hens, and 19, 16 and 20 questionnaires, respectively, were distributed to this group. The questionnaire was sent either via post or electronically during the winter of 1999.

### ***The questionnaire***

A letter explaining the objectives of the study and an example of questions 1 to 7 which had been completed for lameness in dairy cattle were included with the questionnaire, as well as a preliminary example of a welfare-assessment protocol based on observations of the animal and use of farm records for the assessment of lameness in dairy cattle. Initially, experts were asked to identify a welfare issue that they felt should be assessed. They were also asked to rate the importance of this issue to the individual animal and to the UK herd/flock, and to judge how much influence the farmer has on the prevalence of this issue on his/her farm (see questions 1 to 4 in Figure 1). The respondents were encouraged to give information about a minimum of five welfare issues, although they were permitted to copy and complete additional forms to identify a greater number of issues if they wished to do so. The results of this element of the questionnaire for dairy cattle are reported elsewhere (Whay *et al* 2001).

The experts were then asked to continue on to questions 5 to 7 and list the measures (eg locomotion scoring of cows) that they considered should be used in the assessment of the specific welfare issues they had previously identified. Using a six-point scale (0 = lowest score, 5 = highest score), respondents were also asked to indicate how good and how practical the measures they identified would be to assess the welfare state of the animal in a herd/flock during a half-day visit. A half-day visit was stipulated as this was considered to be an acceptable duration for a visit to a commercial unit. They were also asked to provide any known scientific references for the measures they included. Space was provided on the questionnaire to list three potential measures for each welfare issue identified, although the respondents were invited to add more if they wished to do so. In total, therefore, sufficient space was provided for 15 specific welfare measures per species.

The accompanying instructions for the questionnaire also included clarification and definitions of some terms. For the purposes of this study, we defined a welfare issue as “*any quality of life issue that can influence an animal’s mental or physical state*” and asked for “*animal-based measures of welfare state. These may be based on direct observation or farm-based records. The measures selected may address any aspect of the welfare issue; severity, duration and incidence*”.

### ***The second questionnaire***

A second questionnaire was designed on the basis of all of the information returned. The measures were categorised according to the welfare issues they assessed and then divided by method required to gather the information — for example, observation of animals or examination of farm records (first column of Tables 1, 2 and 3). This second questionnaire was then sent to the expert panel. They were sent only the questionnaire which concerned the species to which they had given responses in the first questionnaire.

The experts were invited to indicate the importance of all of the categories of animal-based welfare measures identified in the first round, not only those identified by themselves. In this way, each respondent gave a view on all measures within the species group. Again, a six-point scale was used to allow the experts to indicate how much importance should be

placed on the level of each measure (0 = lowest score, 5 = highest score). These scores of importance were used to calculate the percentage of the maximum possible score (%MPS) that could be achieved if all respondents gave the highest score of 5 for each measure. To assist with this decision-making process, the experts were also sent a summary sheet showing how many scores and what level of score each measure had received in the first questionnaire. In addition, experts were asked to include additional categories that they now considered should be assessed.

Finally, experts were asked to rank the five measures that they considered most important. A cumulative rank score was then calculated for each measure by summing the ranks from each respondent.

## Results

A total of 35 questionnaires were returned, of which 15 were for dairy cattle, 11 for pigs and nine for laying hens. The respondents were derived from three professional groups: veterinary surgeons, farmers and researchers. The dairy cattle expert panel included five veterinary surgeons, four farmers and six researchers. The pig expert panel comprised four veterinary surgeons, two farmers and five researchers, and the laying hen expert panel included one veterinary surgeon, one farmer and seven researchers. Two individuals gave responses for two species (ie cattle and pigs, and pigs and laying hens). Six individuals reported that they did not feel competent to reply and 12 individuals reported that they did not have time to complete the questionnaire.

The experts identified a total of 319 specific measures, of which 147, 83 and 89 referred to dairy cattle, pigs and laying hens, respectively. A total of 525 measures could have been suggested if all respondents had suggested 15 measures.

Of the specific measures identified across all three species, 265 were animal-based (ie were potential indicators of welfare state). These included observations of animal behaviour (98), physical appearance (92) and examination of records (65). The remaining 10 miscellaneous measures related to pain sensitivity in cattle, observation of feathers, red mites and parasitic worms in the laying hen environment, post-mortem limb and joint lesions, lung and abscess lesions in pigs, metabolic profiles in cattle, and heterophil/lymphocyte ratios in laying hens. No professional group was found to have a preference when identifying particular categories of measures.

The 265 animal-based measures were categorised into 22, 23 and 28 groups in cattle, pigs and hens based upon the welfare issue and method of observation. These categories are presented in the first column of Tables 1, 2 and 3 and were used as the basis for the second questionnaire.

Tables 1, 2 and 3 also show the scores indicating how practical and how good an indication of the issue the measures were considered to be. For example, the first measure listed in Table 1 for dairy cattle is 'observe disease'; this was listed three times in the responses received. Of those responses, one respondent gave a score of 3 when considering the usefulness of the measure, one respondent gave a score of 4 and the third respondent gave the highest score of 5. However, when asked to score the practicability of the measure during a half-day visit, two respondents gave a score of 5 leading to a maximum median score. Therefore, to summarise, in the first round of the questionnaire the observation of disease as a measure of welfare in dairy cattle was considered highly important (median score 4) and of maximum practicability, although only three out of fifteen respondents listed this measure. During development of the welfare-assessment protocols, both the scores given for each measure and the number of respondents who selected it were taken into consideration.

The experts also reported a total of 54 measures which were not animal-based. Forty-eight of these measures were related to the assessment of environmental resources. For dairy cattle the environmental assessment included a general assessment of housing conditions (4), features of cubicles (3), cleanliness of the environment (2), feeding trough space (1) and calf pens (1). For pigs the environment measures included assessment of barren conditions/foraging opportunities (6), water and food facilities (5), bedding (cleanliness and thermal comfort) (5), housing space allowance (3), lighting (1), ventilation (4), absence of sharp edges (1) and availability of group housing (1). The laying hen environmental measures identified were general assessment of housing conditions (1), feed and water facilities (2), ammonia levels (2), litter quality (4), nest box provision (1), perch length (1) and general resources (1). Six respondents also included assessment of the stockperson responsible for pigs and dairy cattle. These measures of environmental resource and stockmanship were not included in the second questionnaire.

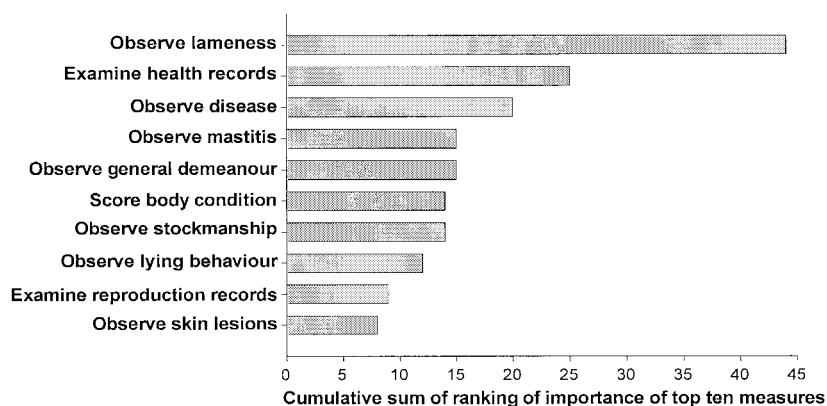
The second questionnaire identified the importance of each individual animal-based measure. The scores and calculated percentage of maximum possible score (%MPS) attributed by each respondent for each measure are shown in the shaded areas of Tables 1, 2 and 3. For example, the scores of importance placed on 'observe disease' by all dairy cattle experts ranged from 1 to 5 with an overall median score of 4, and a calculated %MPS (73%) was used to rank the measure. Accordingly, the two most important measures for each species, according to the %MPS, were observing lameness (89%MPS) and body condition (81%MPS) in dairy cattle, and observing lameness and tail lesions in pigs (both of which were given 84%MPS). Finally, in laying hens, mortality was given 94%MPS while feather appearance and pecking injuries were both given 85%MPS.

The final part of the second questionnaire was the selection and ranking of the top five measures by each respondent, the result of which is expressed as a cumulative sum of all rankings for each measure. Observation of lameness had the highest cumulative rank score in both cattle and pigs (Figures 2 and 3). Feather quality was identified as the most important measure, closely followed by mortality in laying hens (Figure 4). Using a Spearman's rank correlation test, a significant correlation was found between the %MPS and the cumulative ranking for dairy cattle ( $r^2 = 0.992$ ,  $P = 0.000$ ), for pigs ( $r^2 = 0.988$ ,  $P = 0.000$ ) and for laying hens ( $r^2 = 0.918$ ,  $P < 0.000$ ).

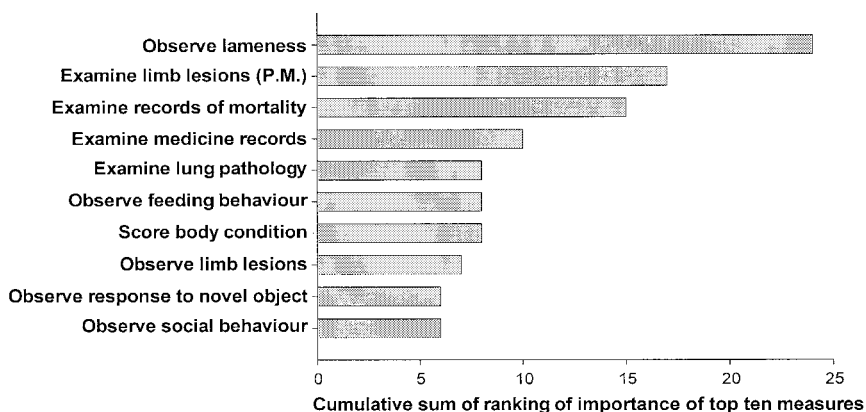
## Discussion

The use of the Delphi technique allowed us not only to gather experts' opinions but also to arrive at a degree of consensus of opinion among these experts. This was demonstrated by the strong correlations between the %MPS and the cumulative rank score. These were calculated from the responses to separate questions asked in the second round of the consultation process. The ranking of importance of the welfare measures gave a useful indication of how they should be prioritised. It should, however, be noted that the measurement of welfare is a rapidly developing science that will continually need to adapt to new assessment and husbandry techniques as well as changing welfare concerns.

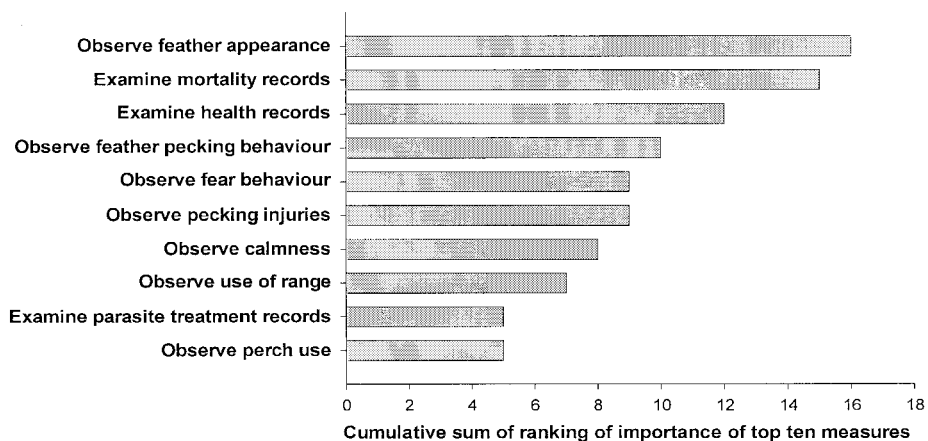
The response rate may be considered to be quite low at 22%. Other Delphi surveys have reported response rates of 33% (Hutchinson & Fowler 1992). A low response to this type of survey is acceptable, as the goal of the study was to broaden the knowledge base from which a welfare assessment protocol could be developed. The responses came from people who felt they had sufficient knowledge and enthusiasm to complete the questionnaire. As the



**Figure 2** Ten animal-based measures of dairy cattle welfare most frequently identified as being of importance by an expert panel.



**Figure 3** Ten animal-based measures of pig welfare most frequently identified as being of importance by an expert panel. P.M., post-mortem.



**Figure 4** Ten animal-based measures of laying hen welfare most frequently identified as being of importance by an expert panel.

particular species-expertise of some of the recipients was not known prior to distribution of the questionnaire, it is likely that some may not have felt competent to respond. Indeed, six individuals did state that they did not feel competent to give a response. In addition, the questionnaire was framed as a set of open questions requiring a great deal of thought, which may have deterred some people from responding. The response rate may have been increased had potential recipients been contacted by telephone before the questionnaires were sent. This may have either inspired a greater number of people to respond or filtered out a number of non-respondents.

The responses covered a broad range of categories including behavioural observation, signs of disease, use of records, post-mortem examination and biological sampling. For dairy cattle and pigs, measures of disease ranked very highly. Inevitably, there was some overlap in the use of measures such as 'incidence of disease treatments' and the actual 'incidence of disease eg lameness'. In the laying hen group, although both mortality rate and health records ranked highly, issues relating to feather quality/pecking were also attributed great importance. A total of 319 measures were identified across the three species. These were refined down to 22, 23 and 28 specific animal-based measures for dairy cattle, pigs and laying hens, respectively, for inclusion in the second questionnaire. Some measures were not included because they were classified as resource or husbandry measures (eg water and food supply, stockmanship). As discussed, these indicators may be useful for assessing welfare; however, the aim of this study was to focus on animal-based measures. Therefore, observations such as body-condition score and the animals' interactions with the stockman are the animal-based measures relating to food provision and stockmanship skills, respectively.

The panels' final opinion on the most important measures was determined when the experts were asked to list the top five measures and to rank them from 1 to 5 in the second questionnaire. These results are displayed in order of importance in Figures 2, 3 and 4. These results are a refinement of the percentage of maximum possible score, as respondents were able to take a number of measures that they considered to be of maximum importance and give them a further rank. Observation of lameness was attributed the highest ranking for both dairy cattle and pigs.

Respondents were also asked to score the practicability of taking each measurement during a half-day visit. The results are shown in Tables 1, 2 and 3. Consequently, measures such as post-mortem examination, measurement of pain through nociceptive threshold testing and use of metabolic profiles were precluded from being suitable for a half-day on-farm welfare assessment because they required access to carcasses, too much time, or were too costly. Measurement of metabolic profiles in dairy cattle was initially identified by one respondent, who considered it to be highly practical. This view was not reflected in the second questionnaire, where it was given a low median score of importance and the lowest percentage of maximum possible score, which meant the expert panel did not rank the importance of this measure very highly.

Consideration must also be given to the quality of each measure. For example, information taken from records of lameness cases may be a quick and practical method of data collection giving information about annual disease rates but it is dependent on the reliability of farmers' monitoring and recording procedures. Many of the suggested animal-based measures rely upon subjective assessments. However, there is no inherent problem with subjective assessment provided that the measures are repeatable. For example, a



recently developed scoring system for assessing lameness in pigs was shown to be consistent once an assessor was suitably trained (Main *et al* 2000).

Although the questionnaires were directed at specific production systems within each species, some measures may be transferable to alternative production systems — for example, from dairy cattle to beef cattle. In the case of a protocol developed to assess the welfare state of laying hens, some animal-based measures such as plumage condition will be greatly influenced by the production system.

Three routes may be considered for bringing about changes to commercial farming practices: enforcement, education, and encouragement. Enforcement is a role primarily fulfilled through Farm Assurance Schemes setting welfare standards to be achieved by their members and by the implementation of welfare legislation. Education is a cornerstone of welfare improvement; however, it often seems to fail to reach farmers or to be applied at farm level. An example of this is the gulf between the level of lameness perceived by farmers and the actual level which is independently observed (Whay *et al* 2002). Finally, a successful encouragement program was implemented in Sweden to reduce foot-pad dermatitis in broiler flocks. Farmers who successfully reduced the level of foot-pad dermatitis within their birds were then allowed to increase, to some extent, the stocking density of their birds. This gave indirect financial encouragement to the producers to improve the welfare of their stock (Algers & Berg 2001).

### ***Animal welfare implications***

The responses to the Delphi survey provide the basis for the development of a protocol for animal-based welfare assessment on commercial farms. We do not think that such a protocol would be suitable as a stand-alone assessment; it can, however, provide a useful tool for the assessment of welfare state. The assessment of welfare state, independent of the physical resources provided to the animal, offers itself as a potential tool for comparison of farm assurance schemes, which currently dictate the resources made available to the animal. This process could also be seen as a way of identifying the strengths and weaknesses of husbandry systems in terms of how they impinge on the animals. The animals can be viewed as the ‘software’ within the system, which is the part that is often most easily damaged, the hardware having been built to endure. For example, many cow cubicles are installed to last for 20 years and remain rigid, while the cows have to fit into the system and will be bruised or injured if they do not. A further application for such a protocol is monitoring the success of any intervention to improve animal welfare on-farm.

### **Acknowledgements**

This work was funded by the Royal Society for the Prevention of Cruelty to Animals. The authors would like to thank the members of the expert panel who gave a considerable amount of time and effort and showed a high regard for the pursuit of improved farm animal welfare. Members of the expert panel are: L Alban, G Barker, K Bazeley, J Bowman, P Brooks, D Chennells, R Eddy, R Eggleston, R Freire, M Geddis, A Gjerloeff, S Haslam, R Henderson, P Johnsen, B Jones, A Joret, C Leeb, C Lindberg, S Lister, M Mendl, C Moinard, G Regula, C Sadler, M Scott, C Sherwin, R Sibley, J Somers, F Wemelsfelder, A White, C Winckler, P Winward.

**Table 1 Dairy Cattle: Summary of responses by 15 experts illustrating a range of welfare indicators, their usefulness, practicability and relative importance. Key: 0 = lowest score; 5 = highest score; Md, median; %MPS, percentage of maximum possible score.**

Measures considered to be useful welfare indicators	No. responses	Responses to First Questionnaire										Responses to Second Questionnaire													
		Suitability of each measure as an indicator of a welfare issue					Practicability of each measure during a half-day visit					Importance that should be placed on the level of each measure					Total no. responses allocated to each score					%MPS			
		0	1	2	3	4	5	Md	0	1	2	3	4	5	Md	0	1	2	3	4	5		Md		
Observe disease	3				1	1	1	4				1	2	5				2	3	3	7	4	73%		
Examine health records	8			1	3	1	2	3				1	2	5				1	5	6	3	4	74%		
Observe calf disease	2			1	1			2.5			1	1		2				1	3	2	4	5	71%		
Examine calf health records	3		2		1		1	1			1		2	5				2	1	5	6	1	63%		
Examine mortality records/age profile	7		1		3	3	3	3			1	1	2	3	4				1	6	5	3	4	73%	
Observe skin lesions	7			1	3	2	4	4			1		2	4	5				2	5	0	4	3	57%	
Observe limb lesions	10				6	2	4	1			1	3	1	2	3				1	1	0	8	5	79%	
Examine records from claw trimming	2		1		1			2.5			1		1		2.5				1	0	7	2	2	55%	
Observe lameness	13			4	6	3	4	4			2		3	5	4				1	1	3	10	5	89%	
Examine lameness records	6		1		2	2	4	4			1	1	1	3	4.5				1	2	2	6	4	73%	
Assess pain sensitivity	1				1			4			1				1				2	4	1	4	4	65%	
Observe mastitis	2		1		1		1	3.5			1		1		2				4	3	3	1	4	57%	
Examine mastitis records	8		1		2	3	3	3.5			1	2	1	4	4.5				2	3	6	4	4	75%	
Observe cow cleanliness	9		1		3	3	2	4			1	2	1	3	2	4				3	1	5	3	3	62%
Score body condition	11		1		1	7	2	4			1	2	5	2	4				1	3	5	6	4	81%	
Examine metabolic profile	1				1		4					1		4					1	4	7	2	1	37%	
Examine yield records	8			2	1	5	5	5				2	6	5	5				1	3	3	4	1	3	53%
Examine reproduction records	8		1	2		4	4	4			1		1	4	5				3	3	2	4	3	3	61%
Observe lying behaviour	8		1	1	2	3	1	4			1	1	2	1	3				1	1	2	8	3	4	74%
Observe social behaviour	7		1		2	2	3	2			3	2	1	1	1.5				1	4	4	5	2	3	66%
Observe general demeanour	6			1	3	2	4	4			1	2	2	1	3.5				1	6	2	3	2	3	55%
Observe animal interaction with stockperson	3				3		4	4			1	2		2				1	4	3	1	6	3	69%	

**Table 2** Pigs: Summary of responses by 11 experts illustrating a range of welfare indicators, their usefulness, practicability, and relative importance. Key: 0 = lowest score; 5 = highest score; - = no score given; Md, median; %MPS, percentage of maximum possible score.

Measures considered to be useful welfare indicators	No. responses	Responses to First Questionnaire										Responses to Second Questionnaire																			
		Suitability of each measure as an indicator of a welfare issue										Practicability of each measure during a half-day visit										Importance that should be placed on the level of each measure									
		0	1	2	3	4	5	Md	0	1	2	3	4	5	Md	0	1	2	3	4	5	Md	%MPS								
Observe lameness	4			1	2	1	2	1	3	1	1	1	1	3	0	1	2	3	4	5	0	1	1	1	3	5	4.5	84%			
Examine records of lameness	2			1	1				3					4								1	2	3	1	5	3	66%			
Observe limb lesions	7			2	3	2	4		4	1			4								1	0	3	2	4	4	76%				
Examine post mortem limb lesions (abattoir)	2			1	1	1	4	1					0								1	1	1	1	6	5	80%				
Examine gross lung pathology	1			1					3				-								2	2	2	2	4	4	76%				
Monitor incidence of abscesses (abattoir survey)	1			1					3				-								1	1	3	2	3	3.5	70%				
Observe coughing	1			1					4				1	5							2	1	1	4	2	4	66%				
Examine records of medicine use (specifically pneumonia)	1			1					4				1	5							7	1	1	2	3	3	70%				
Examine records of mortality	2			1	1	1	4		4				1	5							1	2	3	4	4	4	80%				
Observe skin injury	6			1	1	1	2	4	4				3	3							1	3	4	2	4	4	74%				
Observe pig cleanliness	1			1					5				5	5							2	4	2	4	3	3	48%				
Score body condition	3			1	1	2	5		5				4	4							1	1	2	4	2	4	66%				
Observe tail biting	2			1	1	1	3.5		3.5				2.5	2.5							1	1	1	5	2	4	72%				
Observe tail lesions	2			1	1	1	4.5		4.5				3.5	3.5							3	2	2	4	4	4	84%				
Observe tail length	1			1					5				5	5							2	2	2	2	1	2.5	46%				
Observe tail docking procedure	1			1					4				1	4							0	2	6	1	6	1	44%				
Observe behavioural expression	2			1	1	1	4		4				3.5	3.5							1	1	1	6	1	4	68%				
Observe huddling behaviour	1			1					-				-	-							3	7	3	7	4	4	74%				
Observe social behaviour	2			1	1	1	3.5		3.5				1.5	1.5							1	3	3	3	4	4	70%				
Observe feeding behaviour	2			1					2				4	4							1	2	5	2	4	4	74%				
Observe response to novel object or human	5			1	2	2	4		4				4	4							2	1	2	5	4	4	74%				
Observe behaviour in restricted space	4			1	1	1	1	3.5					4	4							2	3	2	2	3	3	58%				
Observe stereotypies	1			1					-				-	-							1	1	1	4	3	4	72%				

**Table 3** Laying hens: Summary of responses by nine experts illustrating a range of welfare indicators, their usefulness, practicability and relative importance. Key: 0 = lowest score; 5 = highest score; - = no score given; Md, median; %MPS, percentage of maximum possible score.

Measures considered to be useful welfare indicators	No. responses	Responses to First Questionnaire										Responses to Second Questionnaire											
		Suitability of each measure as an indicator of a welfare issue					Practicability of each measure during a half-day visit					Importance that should be placed on the level of each measure					Total no. responses allocated to each score					%MPS	
		0	1	2	3	4	5	Md	0	1	2	3	4	5	Md	0	1	2	3	4	5		Md
Examine birds for disease	4			2	1	1	2.5				2	1	3				1	1	1	1	4	5	77%
Blood sample analysis	1					1	4				1		3				1	1	4		3		42%
Examine health records	3			1	2		4				1		2	5			1	1	2	1	3	4	74%
Examine mortality records	3			2			3			1		2	5							2	5	5	94%
Examine birds for parasites	3			1		1	4			1		1	4				3	3	1	4			74%
Examine environment for parasites	2				2		4			1		2					4	2	1	3			71%
Examine parasite treatment records	1			1		1	1			1		1					2	1	3	1	1	3	51%
Assess landing on perches	3			1	1	1	3				1	2	5				1	1	1	2	2	4	62%
Observe leg weakness	1					1	4				1		4				1	1	3	1	1	3	57%
Observe feather pecking behaviour	6			1		2	4			1		3	5				2	1	3	1	3	4	80%
Observe feathers in litter	1					1	4					1	5				2	1	2	2		2	31%
Observe feather appearance	11			2	4	4	4				3	4	4				1				1	5	85%
Observe beak trimming	4			1	3		5				1	2	5				1	3	2	2	4	3	48%
Observe pecking injuries	3			1	1	1	4				1	1	3	5			1	1	3	2	2	4	85%
Examine records of injuries	3			2		1	2				1	1	4				1	1	3	2	2	3	57%
Observe signs of catching injuries	3				1	1	4					1	5				2	1	2	1	1	3	54%
Observe use of range	7			4	2	3	3			2	1	3	1	4			1	5	1	4			80%
Observe laying behaviour	3				1	2	5			1		1	4				1	1	1	4			57%
Observe perch use	1					1	4											2	2	1	2	3	68%
Observe dust bathing	1			1			2				1		2				2	1	1	4		4	60%
Observe foraging behaviour	1			1			2				1		4				1	2	3	1	4		62%
Observe use of feeders/drinkers	1					1	3				1		4				1	2	3	1	4		65%
Observe use of non-specific resource	3			1	1	1	3			1		1	4				1	1	1	3	4	4	37%
Observe fear behaviour	3			1		2	4				1		2	5			2	1	1	1	1	2.5	40%
Monitor restraint-induced immobility	1						-										3	2	1				20%
Observe agitation/vocalisations	2			1	1	1	2			1		1	3				1	1	1	1	3	4.5	65%
Observe calmness	2			1	1	1	2				1	1	3.5					3	1	2	3.5		65%
Observe aggression	2					1	4.5			1		1	1				1	1	2	2	4		60%

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