Veterinary Record Open

Benchmarking welfare indicators in 73 free-stall dairy farms in north-western Spain

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To cite: Trillo Y, Quintela LA, Barrio M, *et al*. Benchmarking welfare indicators in 73 free-stall dairy farms in north-western Spain. *Veterinary Record Open* 2017;**4**:e000178. doi:10.1136/vetreco-2016-000178

Received 28 March 2016
Revised 2 July 2017
Accepted 25 July 2017

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ABSTRACT

The aim of this study was to describe the status of body condition score (BCS), hock injuries prevalence, locomotion and body hygiene score as animal welfare measures in 73 free-stall dairy cattle farms in Lugo (Spain). A benchmarking process was established across farms: (1) the animal-based indicators were ordered from low to high values; (2) The farms were classified into three categories based on the number of indicators within less than the 25th percentile, 25th to 75th percentile and above the 75th percentile. The median prevalence of unsuitable BCS, hock injuries and clinical lameness was (median (range)) 51.7 per cent (13.3 to 89.5 per cent), 40.0 per cent (7.0per cent to 100 per cent) and 9.0 per cent (0per cent to 60.0 per cent) respectively. The dirtiness of the cow's coat had a high prevalence (73.0 per cent (37.5per cent to 100 per cent)). Most farms did not display consistently good or poor animal-based indicators and each farm had its own set of strong and weak points. Moreover, facilities design and management practices were described to understand source of the observations made of the cows. The incidence of overstocking was 31.5 per cent for stalls and 26.0 per cent for headlocks. The front lunge space was reduced (<90 cm) on most dairies (90.4 per cent). Signs of poor natural ventilation (cobwebs or humidity on the roof) and ammonia odour were observed on 32.8 per cent and 85.0 per cent of the barns totally closed or with a side openingless than 50 per cent of the wall height. The milking parlour was designed with two or more turns more than 90° (9.3 per cent), and failed to allow cows to see the parlour before entering (45.2 per cent). On 52.0 per cent of dairies, more than 15 per cent of the cows had to be forcefully moved into the milking parlour. In conclusion, there was a big variation in the animal welfare levels within and across farms and they could benefit from others by changing management practices related to facilities and herds.

INTRODUCTION

Welfare assessment systems designed for use on farms may differ according to the definition of animal welfare and the purpose of the welfare assessment.[1] Thus, the choice of welfare indicators and methods of measurement reflects basic considerations of how animal welfare is understood.

Although many different assessment systems have been developed in Europe,[1] the recently developed Welfare Quality (2009)[2] assessment protocol for cattle is mainly based on parameters revealing 'direct' cow outcomes by observing the interaction between the animal and its environment. Animal welfare measurements may form the basis of identification of causes of welfare-related problems. However, resource-based and management-based parameters are also needed to highlight the potential risk of a future decline in welfare and help to identify the reasons underlying current animal welfare problems.[3]

Furthermore, good assessment systems should describe the welfare of the animals in the herd and allow the farmer to continuously monitor this parameter and also to respond to any changes over time.[4] Benchmarking is increasingly used to track changes within the same farm over time or, more often, to compare farms. Comparison of the same animal-based measure between farms with similar housing systems and management practices facilitates the identification of farms outside the normal range of variation.[3 5]

Additionally, the overall production process can potentially affect the final results of the food chain ('from farm to table'), affecting the characteristics of high quality animal products, such as beef palatability (eg, low stress prevents pale, soft and exudative meat).[6] The Hazard Analysis and Critical Control Point) system can be implemented to control and monitor the production process.[7] Critical limits for each critical control point can be provided through measurable parameters[4]

Body condition scoring (BCS) is a quantitative tool for determining too thin, too fat or ideal conditions depending upon stage of lactation, as well as for monitoring ketotic cows.[8–10] Several management practices (eg, unbalanced rations, prolonged dry periods, overfeeding during the dry period or poor reproduction management) may affect overconditioning and lead to disorders (such as fatty liver, ketosis, displaced abomasum, etc) that may decrease reproductive and productive performance.[10] Similarly, postcalving lowering of the BCS is commonly associated with high milk production, reproduction and health issues such as lameness.[11 12]

Injuries to the hock, on the tarsal joints, are characterised by hairless patches and lesions/swellings in extremely exposed areas, that are sensitive to pressure when the cow is lying down on a hard and/or abrasive surface with poor hygiene.[13–15] These lesions are painful and may force the animal to stand up or lie down for longer intervals.[16]

Lameness is often described as one of the most important and severe welfare-related problems in farms for reasons that include pain (such as hock injuries), changes in cow behaviour, and adverse effects on milk yield and reproduction.[17 18] The locomotion score of farm cattle evaluates certain walking behaviours and postures that are thought to be indicative of lameness.[19–22] Use of the locomotion score may help to identify cows at the early stages of lameness and therefore enables faster recovery and reduced treatment costs. Research to date has shown that facility design and management can affect lameness, which in turn affects cow welfare and longevity.[23 24] Furthermore, research indicates that farmers tend to underestimate the prevalence of lameness in their herds.[25] Despite being a subjective assessment, monitoring of locomotion scores and the prevalence of lameness may be useful for evaluating the functionality of the barn design.

Body hygiene is an indicator of the environmental cleanliness at herd level. Several methods of hygiene scoring have been documented for scoring different zones of the cows' coat, although mainly focusing on the rear limb, that is, lower leg, udder and upper leg/flank.[26 27] Use of some of those systems has demonstrated that poor hygiene leads to udder problems, as manure may compromise cow comfort and increase the risk of intramammary infections.[27]

The aim of this study was to describe BCS status, occurrence of hock injuries, locomotion score (as a measure of lameness) and body hygiene score as animal welfare measures in dairy cows housed in free stalls. A benchmarking process using these animal-based parameters would allow producers to identify opportunities for improvement across farms. Furthermore, this paper provides a description of facility design and management practices that may affect cow comfort and welfare in 73 free-stall farms located in Lugo, Galicia (north-western Spain).

MATERIAL AND METHODS

Farm selection and description

A convenience sample of free-stall Holstein dairies were recruited for participation in the study with the assistance of three dairy veterinarian practitioners. Those vets were responsible for choosing the farms and explain farmers the purpose of the study (their actual clients on reproduction management). Some farmers rejected to perform the sampling for several reasons such as availability, lack of interest or consent to copy data records. Therefore, farmers voluntarily agreed to participate and were enrolled in the study once a review of data record availability (ensuring all farms got the same source of data to be able to compare among) and reliability (ensuring data was properly collected and numbers make sense in regards of their source) confirmed their eligibility for inclusion in the study. One researcher (YTD) accompanied the farm veterinarian during the farm's scheduled pregnancy check so that all farm assessments were performed in a single visit. Before the assessment, dairy farmers were informed of the nature of the study and offered an aggregate data summary after study completion. Those farms agreeing to participate were visited between November 2011 and March 2012. The dairy farms were located in the province of Lugo (Galicia, north-west Spain). Herd size ranged from 20 to 244 cows, with an across-farms median of 43 cows, and nine of the farms hosted more than 100 cows. Most farms milked the cows twice a day (97per cent) and only two farms (2.7per cent) milked three times a day. Records from the 12-month period before the audit showed an average herd milk production (305 days mature-equivalent (305ME); n=63 herds) of 9.141 kg. Feed mainly consisted of total mixed ration delivered once (n=5) or twice a day (n=61), although some farms also fed cows separately with concentrate and silage, twice a day (n=7). All farms confined cows all year round except when good weather conditions allowed cows to remain outdoors (33per cent). Moreover, dry cows were on pasture all year round on 51per cent of the farms. All farms were family owned and the age of the facilities (since the last restoration or as a new building) ranged between 5 years and 20 years old, as reported by the farmers. During the assessment, humidity levels ranged from 80per cent to 100per cent and temperatures from 0°C to 14°C.

Data collection

The farm assessment comprised three sections: (1) animal-based parameters, (2) facility-based parameters and (3) farmer survey.

Measurements were made only once on every farm at around the time of the first milking (7.00 to 9.00) by the same assessor. Data records of herd milk production and reproductive performance were provided by reproduction veterinarians (software records of one year before the visit). All data results were based of the herd/farm and data were analysed and reported across the 73 farms.

Animal-based parameters

Only lactating cows (n=3426) were included in the study, in order to prevent results being skewed by the housing conditions of dry cows kept on pasture all year round relative to those housed inside the barn (ie, assessing locomotion on grass v concrete floors).

All lactating cows on each farm were released from the headlocks and scored individually by direct observation (direct indicators) from an average distance of 300 m for locomotion and as close as necessary (60 cm to 120 cm) for BCS, hock injuries and hygiene status.

Body condition score

On each farm the cows were evaluated on a scale of 1 (severely underweight) to 5 (severely overweight) using 0.25-point increments to extend the work of Edmonson.[28] The spreadsheet designed by Coleen and Heinrichs[9] was then used to classify BCS within each herd as suitable (within the thresholds), high (overweight=above upper threshold score) or low (underweight=below lower threshold score). Thresholds for determining BCS category during lactation could be modified on the spreadsheet. And, they were set according to the authors' previous studies based on days in milk (DIM) (unpublished data): BCS of 2.5–3.5 for 0–30 DIM; BCS of 2.25–3.0 for 30–100 DIM; BCS of 2.25–3.0 for 100–180 DIM; and BCS of 3.0–3.5 for 180–300 DIM. Results are stated as the percentage of cows with unsuitable BCS by lactation stage across herd.

Hock injuries

The tarsal joints of each cow within each herd were evaluated. A hock scoring system was not applied to minimise the time cows were immobilised by head locking (farmer's consent). Only the occurrence of scratches, swelling, abrasions or trauma on one or both hindlimbs were recorded. Results are presented as percentage of cows with hock injuries across herds.

Locomotion score

Each cow was given a score of between 1 (sound) and 5 (severely lame) according to guidelines proposed by Sprecher and others.[19] Clinical lameness was defined as cows with scores at least 3 and cows were considered to be severely lame with scores at least 4. Overall and herd level distributions of locomotion scores are reported as percentage of lame cows (scores 3, 4, 5).

Hygiene score

Lower leg (rear only), udder and upper leg/flank were scored on a scale between 1 (free of dirt) and 4 (covered with caked on dirt) according to guidelines reported by Schreiner and Ruegg.[26] A hygiene score more than 2 indicated dirty cows within a herd. Overall dirtiness of the cow's coat was calculated as the percentage of cows by herd with an average score of the three zones with hygiene score more than 2.

Data records of *productive and reproductive performance* (indirect indicators) were described via several parameters across herds. Average total herd milk production was projected to 305ME (kg – standard measure used to establish comparisons between populations and consisting of correcting the milk production of a cow by estimating a 305 days lactation period, delivering once a year with 60 days of dry-off). Monthly results of milk bulk tank somatic cells count (BTSCC) for the period when the audit was carried out (cells/mL) and yearly average of DIM were also collected. Ten farms had no dairy herd improvement data registers, and thus only 63 farms were included for production data. Six reproductive parameters were considered as the most important (for one year calculations and all year round calving):

1. Calving to first service interval (CFSI) in days
2. Calving to conception interval (CCI) in days
3. Average calving number (CN) = sum of the deliveries by cow/number of delivery cows
4. Conception at first service (FSC) per cent = number of pregnant cows after first insemination/total cows inseminated the first time ×100
5. Heat detections (HD) per cent = number of cows inseminated every 21 days/total cows ready to be inseminated ×100
6. Average conception (C) per cent = number of pregnant cows/total cows inseminated×100

Culled cows were not included in the above calculations as this was considered an unreliable measure, dependent on farmer data records.

Facility-based parameters

A total of 31 measurements were taken, using direct observation or measuring tape or laser, in five different areas of the barn (8 parameters for resting, 5 for walking, 8 for feeding, 5 for ventilation and 5 for milking, Table 1). Three stalls were sampled on each farm (every five in a row) to enable calculation of average stall dimensions including bed width, bed length, brisket locator height, total stall length, low lateral bar, high lateral bar, neck rail height, neck rail position, front lunge space and rear curb height (Fig 1). Bed length of the stalls without brisket locator was measured to the first barrier blocking the front. Space available in the stall was calculated by the following formula: width×length (cm)/1.000, expressed in m^2. Overstocking in the stalls and in the headlocks was defined as a ratio (number of animals/number of spots×100) more than 100 per cent. All farms had stalls in the resting area and headlocks in the feeding area.

Management practices of facilities and herd

Farmers were interviewed regarding the frequency and procedure of outdoor access for lactating cows, bed maintenance, cleaning practices (floor, feed bunk and water troughs), water analysis, environmental enrichment (brushes), footbath protocol, yearly hoof trimming/inspection routine, mechanical ventilation (when available) and settings, milking practices and cow behaviour in the milking parlour (>15.0 per cent of the cows per herd): refusal to enter the parlour voluntarily (farmers reported having to push cows at every milking session) and/or showing other signs of stress (defecation, urination, kicking, fast tail movements). The farmers were asked in advance (by phone) to count the number of cows displaying any of the above-mentioned types of behaviour during the first milking session on the day of

TABLE 1 Description of the facility-based parameters determined by direct observation or measured in five areas of the free stalls on 73 dairy farms in north-western Spain

Area	Parameters (N of levels)	Description of continuous parameters/levels of categorical parameters			Median	Min–max
Resting	Stall stocking density	Number of cows/number of stalls×100 (%):			98	55–186
	Stall dimensions (as described in Fig 1)	Bed width (cm)			120	90–135
		Bed length (cm)			185	60–230
		Brisket locator height (cm)			20	5–50
		Total stall length (cm)			240	200–325
		Low lateral bar (cm)			30	0–70
		High lateral bar (cm)			60	20–90
		Neck rail height (cm)			115	90–140
		Neck rail position (cm)			165	85–190
		Front lunge space (cm)			60	0–115
		Rear curb height (cm)			28	15–40
	Brisket locator presence	Concrete/board/tube/bedding material			85% yes	15% no
	Slope of platform	Slope towards the rear			64% yes	36% no
	Stall location (3)	85% head to head platform		12% against a side wall		3% both combined
	Design of dividers (4)	45% Italian		21% Michigan	18% 'U' loop	16% wide span
	Type of bedding material (4)	45% rubber mats		29% Sand/straw/strawdust	18% No bedding	8% mattresses
	Bedding material dryness (2)	"knee test"- dry after 3 seconds kneeling on bedding material			52% yes	48% no
Walking	Surface characteristics (3)	Concrete: assessed by grazing with booted foot				Flat (22%): 4 rough/8 slippery/4 unclassified
		Slatted (21%): 13 slippery		Grooved (58%): 4 slippery		
	Dirty alleys	Manure evenly covered the floor at a depth of at least 2 cm (16%)				
	Rubber on the floor	Milking parlour (n=2)		Feeding alley (n=1)		
	Alley width	100% feeding alley (cm)	400	240–500		
		96% back alley (cm)	300	0–620		
		95% crossovers (cm)	160	90–350		
		85% crossovers curb (cm)	25	5–40		
	Blocked alleys	Mobile fences and/or chains obstructing linear circulation within a pen of groups of cows (18%)				

Continued

TABLE 1 Continued

Area	Parameters (N of levels)	Description of continuous parameters/levels of categorical parameters			Median	Min–max
Feeding	Feed bunk characteristics	Assessed by grazing with booted foot: 26% smooth (26%)			74% rough (worn)	
	Feed bunk height	Difference between cow platform to feeding platform height (cm)		10	0–50	
	Feed bunk space/cow	Headlock's width (cm)	65	50–70		
	Feed bunk stocking density	Number of cows/number of headlocks×100 (cm)	96	50–178		
	Lighting at feed bunk	Visual perception, feed bunk lighter than the rest of the barn	51% yes	49% no		
	Trough characteristics	54% metallic with a draining system	39% concrete troughs fixed with a drain	8.2% a combination of the previous two		
	Linear watering space/cow	Total length from all accessible sides/number of cows (cm)	8.4	2.6–32		
	Covered feed bunk	Roof covering the feed bunk	100% yes	0% no		
Ventilation	Signs of poor ventilation	Humidity and/or cobwebs (>1m^2 roof) and smell of ammonia	33% yes	67% no		
	Roof insulation	Insulation materials	12% yes	88% no		
	Open ridge	Gap in the roof for natural ventilation, dividing the 2 ceilings	0% yes	100% no		
	Open sides and height	Gap on side wall barn and measurement of the gap (cm)	146	20–300		
	Roof height	Measure from the floor to the middle of the roof (cm)	700	400–1000		
Milking	Area before milking parlour	2.7% walkway or release area			74% holding area	
	Holding area space/cow	Width×width/number of cows fitting in the parlour (cm)			1.2	0.7–1.7
	Floor characteristics in holding area	Slope (%): difference in height/length×100			2	0–15
		Grooved floor - parallel lines			23% yes	77% no
		Entrance door width, direct to the parlour or by holding area (cm)			250	100–800
	Milking area design	Straight design: cows can see the parlour from the holding area			55% yes	45% no
		49% non-linear paths (≥2 turns: turns ≥90° at parlour entrance or exit)				
		Exit door width, from milking parlour to alley (cm)			110	90–300

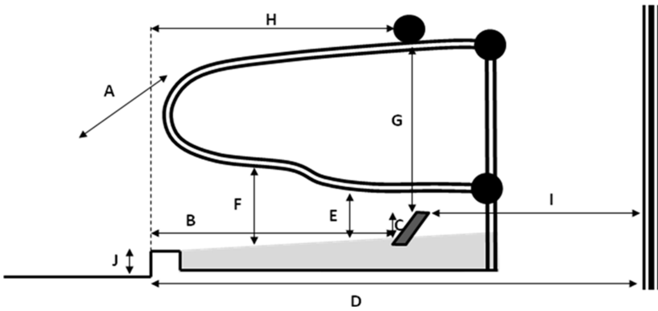

FIG 1 Stall dimensions (median, range) on 73 dairy farms in north-western Spain. Bed width (A) from the middle of one side divider to another; bed length (B) from the external side of the rear curb to the internal side of the brisket locator if available (when brisket locator not present, measurement was made to the first barrier); brisket locator height (C) vertical line from the bottom to the top; total stall length (D) from the external side of the curb to the middle front with the other stall or to the wall; low lateral bar (E) and high lateral bar (F), from the bed to the bottom of the bar; neck rail height (G) from the bedding surface to the bottom of the rail; neck rail position (H) distance from the vertical plane above the rear curb to the internal side of the rail; front lunge space (I) distance from the middle of the brisket locator to the half way with another stall or to the wall; rear curb height (J) from the bottom of the alley to the top

the visit. The frequency of these practices was reported in number of times per day, or year, and 'when farmers considered it necessary' (not routinely).

Benchmarking animal-based parameters

The overall benchmarking process included four direct animal-based indicators; the percentage of cows in each herd with unsuitable BCS by lactation stage, hock injuries, clinical lameness and overall dirtiness of the cow's coat. First, each indicator was ordered from low to high values, and three categories were established across farms for each indicator: category A represented the 25 per cent with the lowest prevalence (25th percentile), category B included 50 per cent of the farms (75th to 25th percentile) and category C included the 25 per cent with the highest prevalence (75th percentile). Each farm was then ranked by the number of indicators in categories A and C. The number of farms included in each category was determined after sorting farms from A to C categories across indicators and exploring data: top-ranked farms were defined when at least two indicators were classified in category A but zero in category C (n=11), and bottom-ranked farms were defined by at least two indicators included in category C and no indicators in category A (n=11). Furthermore, a description of the facilities design characteristics and specific management practices carried out in the top-ranked and bottom-ranked farms (classified by the animal-based welfare indicators previously) is provided.

Productive and reproductive parameters were ranked by the same percentiles used for the animal-based direct indicators; however, these parameters were not included in the overall benchmarking process as they are indirect measures of cow welfare.

Finally, farmers were provided with feedback through an anonymous report, thus giving them an opportunity to improve their herd rating through the benchmarking process of the 73 farms.

Data analysis

Descriptive data analysis was conducted with SAS V.9.4 (SAS Institute, Cary, North Carolina, USA). The results are presented as proportions expressed as per cent with either median values (minimum – maximum) or as percentiles (25th, 50th (=median) and 75th).

Pearson's correlation analysis was applied within and across the four animal-based welfare indicators used in the overall benchmarking process to determine associations between welfare signs (ie, dirtiness may predispose cows to infection of the hoof and develop lameness as well as hock injuries that may cause lameness) and also between reproductive parameters, which may be affected by certain management practices (ie, artificial insemination management, related to CFSI, FSC per cent, CCI and C per cent).

Data description are presented as follows: First, a description of the prevalence of animal-based parameters was reported at herd level. Second, facilities design and management practices were described across farms. Third, the prevalence of the issues found of the cows by herd was ranked on a benchmarking process. Moreover, a description of the management practices of the facilities and the herd was provided for the classified farms with low and high prevalences across animal-based parameters.

RESULTS

Each veterinarian (n=3) had around 30 clients with farms on free stalls and more than 20 from each were selected for the study.

Animal-based parameters

The animal-based parameters, including direct indicators of cow welfare and indirect measures of cow comfort are summarised in Table 2.

Across farms, the percentage of cows with suitable BCS for DIM was (median (range)) 48 per cent (11 per cent to 87 per cent), while overweight and underweight cows were 28 per cent (0 per cent to 79 per cent) and 18 per cent (0 per cent to 90 per cent), respectively. Only four (5.5 per cent) and nine (12 per cent) herds had less than 5 per cent of cows above and below the desirable BCS, respectively, at the assessment time (Fig 2). All herds had less than 3 per cent of lactating cows with a BCS less than 2, however most herds (55 per cent) had more than 3 per cent of the cows with a BCS above 4. The prevalence of overweight cows was significantly correlated with underweight cows ($r=0.637$; $P<0.0001$).

The distribution of hock injuries varied widely across herds, from 7 per cent to 100 per cent of cows within a

TABLE 2 Percentiles (25th, 50th and 75th) of animal-based direct indicators, including unsuitable body condition score for lactation stage, hock injuries, clinical lameness (locomotion score 3, 4, 5) and dirtiness of cow's coat (average percentage of cows with hygiene score >2 in the three zones of cow's coat), and indirect indicators including productive and reproductive parameters assessed on 73 dairy farms in north-western Spain

Description of parameters based on the animal	Percentile		
	25th	50th	75th
Animal-based welfare indicators (n=73 dairy farms)			
Unsuitable body condition score (%)	42	52	61
Hock injuries (%)	25	40	56
Clinical lameness (%)	5	9	16
Dirtiness of cow's coat (%)	63	73	83
Productive parameters (n=63)			
BTSCC (cells/mL)	154	186	254
DIM (days)	157	184	202
Herd milk production (305ME, kg)	8.434	9.111	9.734
Reproductive parameters (n=73)			
Days of calving to first service interval (CFSI)	70	75	81
Percentage of conception at first service (FSC %)	23	30	35
Calving to conception interval (CCI)	132	152	171
Percentage of heat detections (HD %)	49	53	60
Average of calving number (CN)	2.3	2.4	2.8
Percentage of average conception (C %)	30	34	37

305ME, average total herd milk production projected 305 days mature-equivalent in kg; BTSCC, bulk tank somatic cells count of the sampled month (cells/mL); DIM, days in milk (yearly average)

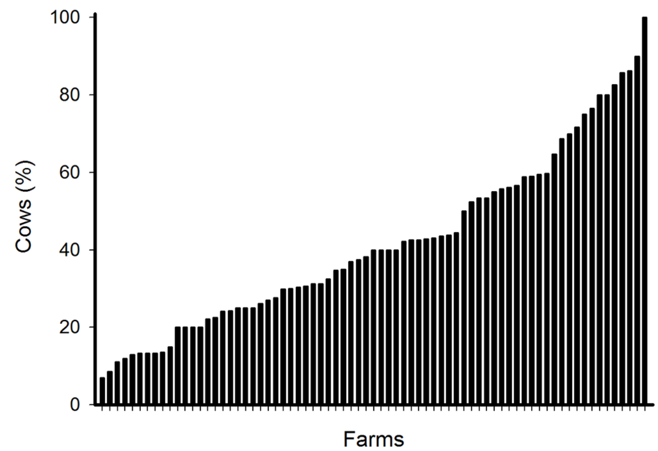

FIG 3 Percentage of cows per herd with hock injuries on 73 dairy farms in north-western Spain. Farms ranked from low to high percentage of hock injuries (left to right)

herd affected (Fig 3). Only 11 herds (15 per cent) had less than 15 per cent of cows with no lesions, whereas 13 herds (18 per cent) had more than 60 per cent of cow with lesions.

The distribution of locomotion score 1 was 61 per cent (23 per cent to 82 per cent), while score 2 was 28 per cent (7.7 per cent to 57 per cent). The prevalence of score 3 was 6.3 per cent (0 per cent to 35 per cent) and of scores 4 and 5, 0.8 per cent (0 per cent to 20 per cent) and 0.0 per cent (0 per cent to 13 per cent), respectively. The prevalence of clinically lame cows ranged from 0 per cent to 60 per cent (Fig 4). Severe lameness was 3.8 per cent across farms and was positively correlated with clinical lameness (r=0.753; P<0.0001). Farms (n=7) without lame cows (clinical or severe) had a prevalence of score 2 between 20 per cent and 45 per cent.

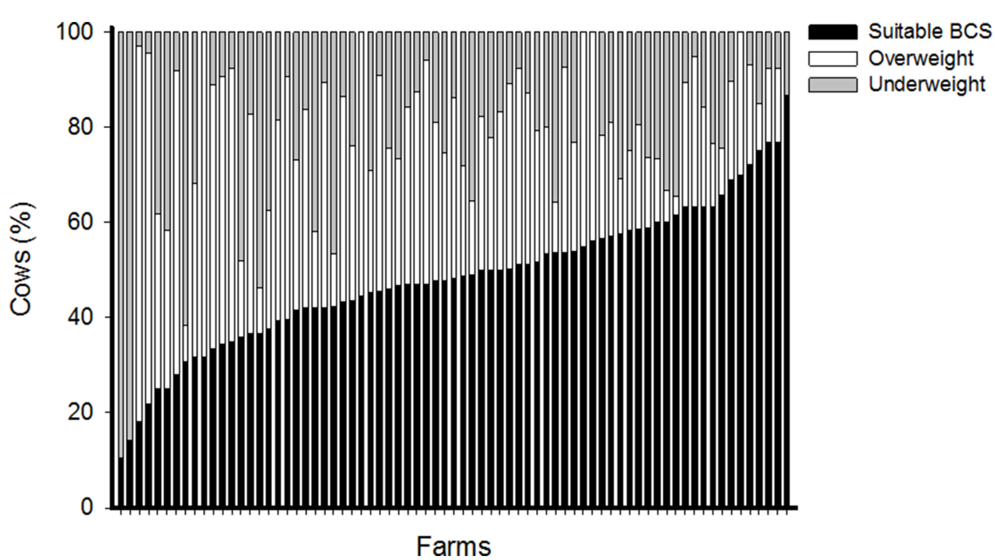

FIG 2 Distribution of the body condition score (BCS) for cows per herd as the percentage of cows with suitable, high or low BCS in relation to lactation stage on 73 dairy farms in north-western Spain. Farms ranked from low to high prevalence of appropriate BCS (left to right)

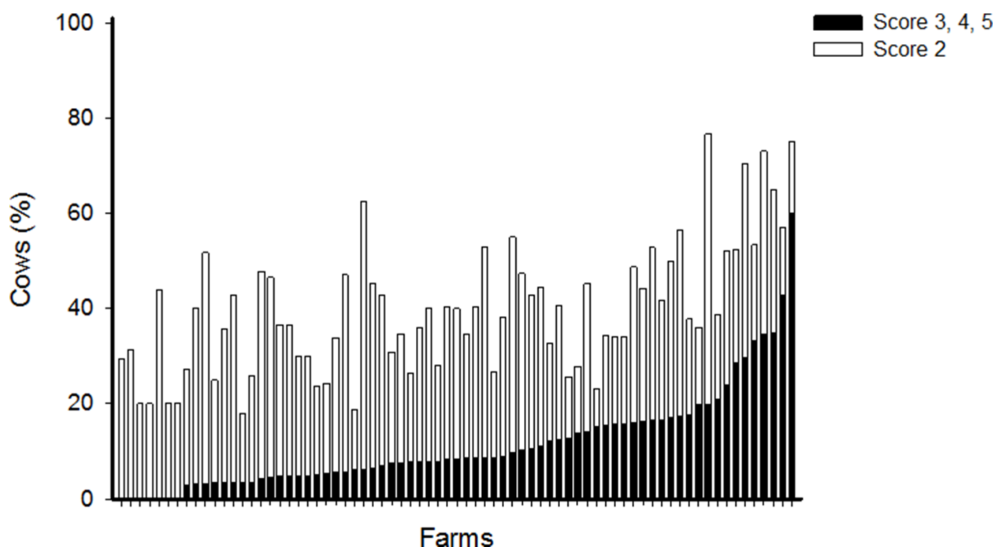

FIG 4 Percentage of cows per herd with locomotion scores of 2 and of 3, 4, 5 (indicating lameness) on 73 dairy farms in north-western Spain. Farms ranked from low to high percentage of lame cows (left to right)

Dirty lower legs, udders and upper leg/flank had a median (median (range)) of 95 per cent (50 per cent to 100 per cent), 63 per cent (25 per cent to 100 per cent) and 63 per cent (25 per cent to 100 per cent) of the cows by herd and across farms, respectively. Scores for the three zones of cow's coat were significantly correlated (r=0.814; P<0.0001). Overall dirtiness of the cow's coat (per cent of cows scored >2 across body regions) averaged from 38 per cent to 100 per cent across herds.

The total milk production (305ME) ranged from 6.321 kg to 11.951 kg. Milk production by cow and day varied widely, from 23 kg to 44 kg, and 30 per cent of the herds produced an average of less than 30 kg. Cow DIM also varied widely (88 days to 251 days) and was less than 155 days and more than 175 days in 27 per cent and 62 per cent of the herds, respectively.

The correlations established in relation to reproduction were unsurprising: HD per cent and CFSI were negatively correlated (r=−0.628; P<0.0001), whereas FSC per cent and C per cent were positively correlated (r=0.659; P<0.0001). The CFSI ranged from 56 days to 116 days and was more than 80 days in 32 per cent of the herds. The CCI was between 103 days to 243 days; on most of the farms (97.3 per cent) the CCI was more than 115 days, and it was more than 145 days in 59 per cent of the herds. A wide range of variation was found in FSC per cent, HD per cent and C per cent (ie, from 10 per cent to 63 per cent, 30 per cent to 69 per cent and 16 per cent to 49 per cent, respectively). Low HD per cent (<50 per cent) was observed in 33 per cent of the herds and also low FSC per cent (<35 per cent) for most farms (73 per cent). The CN ranged from 1.7 to 3.7 across farms.

Facility-based parameters

Facility design varied across farms (Table 1).

Resting area

The incidence of overstocking was 32 per cent (n=23) across farms. This was observed when dry and lactating cows were housed in the same pen (n=4; 17 per cent) separated by chains and/or mobile fences (n=13; 57 per cent) or there was a lack of space for the number of cows (n=6; 26 per cent).

Most farms (n=54; 74 per cent) had stalls of width between 115 cm to 122 cm; however, stall width was more than 125 cm on some farms (n=10; 14 per cent). By contrast, stall length was 178–182 cm or >185 cm on 32 per cent and 40 per cent of the farms, respectively. Therefore, only 21 per cent of the farms had available space of between 2.0 m^2 and 2.2 m^2. Furthermore, the front lunge space was less than 90 cm in length on most farms (n=66; 90 per cent) and more than 90 cm on a few farms (n=7; 9.6 per cent). Some farms (n=43; 59 per cent) placed the neck rail at less than 115 cm (height) and few (n=10; 14 per cent) at more than 122 cm. Furthermore, curb height was above 25 cm in 67 per cent of the farms.

Divider design and bar position explained the range of variation in high and low lateral bars. On most farms (n=69; 95 per cent), the height of the high lateral bar was usually above 35 cm and was below 30 cm on only one farm.

Walking area

Back alley, when present (96 per cent), was less than 350 cm in 80 per cent of the farms and most feeding alleys (64 per cent) were less than 420 cm in width.

Feeding area

Feed bunk height was 10–15 cm in 51 per cent of the farms and above 15 cm in 14 per cent.

Fewer headlocks than cows were available at the time of the visit on 19 farms (26 per cent). Furthermore, most farms overstocked at headlocks (n=15; 79 per cent) were also overstocked at stalls. Feed bunk space (headlock width) was less than 60 cm on 25 per cent of the farms.

Linear watering space per cow was less than 8 cm on 43 per cent of the farms.

Ventilation area

Farms were partly closed with small windows in the side wall (n=15; 21 per cent) or partly open with small open sides (n=57; 78 per cent). Only one farm had 75 per cent of the side wall open (400 cm). Therefore, the open side represented less than 50 per cent of wall height in 47 out of the 58 farms. Fans and sprinklers were available on a few farms (14 per cent and 1.4 per cent, respectively).

Milking area

Holding area space per cow was less than 1.3 m^2 on 50 per cent of these farms (n=27) and slope of the holding area was more than 4.0 per cent on 24 per cent of the farms (n=13). Furthermore, all farms provided access between the milking area and the barn, either through the release/holding area (n=54; 74 per cent) or with direct access to the milking parlour (n=19; 26 per cent). The entrance door was more than 300 cm in width for less than 100 cows, and more than 500 cm in width for more than 100 cows on 42 per cent of the farms. Exit paths in the holding area were more than 160 cm on 9.7 per cent of the farms. Additionally, on some farms (n=33; 45 per cent), the design of the milking area did not allow cows to see the milking parlour before entering it.

TABLE 3 Distribution of categorical variables for management practices on 73 dairy farms in north-western Spain

Categorical variable	Level	Frequency (%)
Frequency of bed cleaning	'When necessary'	12
	1 daily	15
	At least 2 daily	73
Hoof trimming routine	'When necessary'	49
	1 yearly	12
	At least 2 yearly	38
Frequency of feed bunk cleaning	'when necessary'	2.7
	1 daily	88
	2 daily	9.6
Frequency of trough cleaning	'when necessary'	82
	1 daily	14
	2 daily	4.1

Management practices of facilities and herd

Cow and facility management varied widely across farms as shown in Table 3 for several categorical variables.

All lactating cows on each farm had access to outdoor exercise areas (n=14; 19 per cent) or pasture (n=10; 14 per cent) when the farmer considered the weather was suitable.

Daily bed maintenance mainly consisted of removing manure from the cubicles. As part of stall hygiene procedures, calcium carbonate was sprinkled on the concrete, rubber mats, mattresses and waterbed. Beds of sand, straw/sawdust and soil were racked and replaced 'when necessary'. Most farmers (n=63; 86 per cent) reported removing manure with an automatic scraper at least twice a day on a random schedule

TABLE 4 Ranking of the top and bottom 15 per cent of the farms ordered by the number of animal-based welfare indicators (unsuitable body condition score for the lactation stage, hock injuries, clinical lameness (locomotion score 3, 4, 5) and dirtiness of the cow's coat (average of the percentage of cows with hygiene score>2 in the three zones of the cow's coat)) in A (at least two indicators and zero in category C; white) more than B (grey) more than C (at least two indicators and zero in category A; dark grey) categories. Each indicator was previously ordered from low to high prevalence across farms and grouped into three categories: A represents the 25 per cent of the farms with the lowest prevalence of each indicator, B represents the 50 per cent of farms and C the 25 per cent of farms with the highest prevalence of each indicator

Indicator - percentage of cows per herd (%)	Top 15% dairies										
Unsuitable body condition score (%)	B	A	A	A	B	B	B	B	B	B	B
Hock injuries (%)	A	B	B	B	B	A	A	A	A	A	A
Clinical lameness (%)	A	A	A	B	A	B	B	A	A	A	A
Dirtiness of cow's coat (%)	A	B	B	A	A	A	A	B	B	B	B
Indicator - percentage of cows per herd (%)	**Bottom 15% dairies**										
Unsuitable body condition score (%)	C	C	C	B	C	C	B	B	C	C	C
Hock injuries (%)	B	B	C	C	B	B	C	C	C	C	C
Clinical lameness (%)	B	B	B	B	C	C	C	C	C	C	C
Dirtiness of cow's coat (%)	C	C	B	C	B	C	C	C	B	B	C

and the remaining 14 per cent had a fixed schedule of up to six times a day.

Several farms (n=31; 43 per cent) had footbath facilities but did not have a footbath protocol; most farmers reported that they did not change the product more than once a month (23 out of 31 farms) or they used it 'when considered it necessary' (8 out of 31 farms).

Some farms (n=20; 27 per cent) had at least one cow brush in the alleys.

When fans/sprinklers were present (14 per cent), farmers reported turning these on during the summer, but not routinely.

All farmers cleaned the feed bunk before feeding delivery (in the morning) and they also performed a water analysis yearly.

A total of 38 farms (52 per cent) reported that more than 15 per cent of the cows had to be forcefully taken into the milking parlour on a daily basis. Observations on 15 of the 19 farms without a holding area revealed that the pathway to the milking parlour was not linear because it did not allow the cows to look into the milking parlour before arrival and, in 15 cases the farmers were forced to lead the cows themselves. At least one stressful reaction (defecation, urination, kicking, fast tail movements) was observed in more than 15 per cent of the cows at milking time in 19 per cent of the farms.

Benchmarking animal-based parameters

The cut-off point considered to assign the categories for each indicator across farms is included in Table 2. Across all farms, the number of indicators in A, B and C categories ranged from 0 (n=22) to 3 (n=1), 0 (n=4) to 4 (n=7) and 0 (n=32) to 4 (n=1), respectively. There was no correlation between the four animal-based welfare indicators, and only one farm had all indicators in category C. Ten farms had the same number of indicators in A and C categories, and seven farms had the four indicators in category B. However, 11 farms had zero indicators in category C and other 11 in category A, which were the top-ranked and bottom-ranked farms, respectively (Table 4).

The number of lactating cows was similar for top-ranked and bottom-ranked farms, and was eight linear units higher (median) in the top-ranked farms. Herd milk production and DIM were also similar, representing 100 kg and −93 DIM of linear unit difference (median) between top and bottom farms. The median BTSCC was 264.000 cells/mL and 310.000 cells/mL in the top-ranked and bottom-ranked farms, respectively. The difference in all reproductive parameters was less than six linear units (median) between both groups of farms.

The stall stocking density was 98 per cent (74 per cent to 117 per cent) on the top-ranked farms and 100 per cent (68 per cent to 154 per cent) on bottom-ranked farms; a similar situation was found for the headlocks, with 94 per cent (73 per cent to 117 per cent) and 103 per cent (71 per cent to 143 per cent) in the top-ranked and bottom-ranked farms, respectively. However, similar numbers of blocked alleys were observed in the top and bottom farms (six and seven, respectively).

Frequency of bedding maintenance did not vary between top-ranked and bottom-ranked farms and none of the farms used sand bedding. However, most of the top-ranked farms (n=7) had dry bedding materials while most of the bottom-ranked farms (n=7) did not. The difference in front lunge space was 10 cm between top-ranked and bottom-ranked farms. Brushes were included in the alleys on four of the farms. Dirty alleys were observed in two and three farms of the top-ranked and bottom-ranked groups, respectively. The difference between top-ranked and bottom-ranked farms in the width of the feeding alley was 50 cm and in the width of crossovers curbs, 5 cm. Hoof trimming was performed at the farmers' discretion on most of the bottom-ranked farms (n=9), while most of the top-ranked farms carried this task out at least twice a year (n=7).

Only six top-ranked farms had good illumination over the feed bunk as well as in the rest of the barn. Feed bunk space per cow was similar (averaging 60 cm) across top-ranked and bottom-ranked farms. However, feed bunk was smooth in five of the top-ranked farms and rough in bottom-ranked farms.

Signs of poor ventilation (as described in Table 1) combined with a closed barn design (no open sides walls to promote natural ventilation) were observed on five of the bottom-ranked farms, while all the top-ranked farms seemed to be well ventilated.

Most of the bottom-ranked farms (n=9) did not have a holding area and on seven of these, the farmers reported having to manually push cows into the parlour. However, in most of the top-ranked farms (n=9) there was a holding area and only two farmers reported having to help cows enter the parlour. Furthermore, the holding area space per cow ranged from 0.7 m^2 to 7.7 m^2 on the top-ranked farms (n=9) and 1.0 m^2 to 2.1 m^2 on the bottom-ranked farms (n=2). The slope of the holding area was between 2.0 per cent to 4.0 per cent on most of the top-ranked farms (seven out of nine farms with holding area), while the slope on the two bottom-ranked farms was 4.0 per cent and 15 per cent.

DISCUSSION

This study constitutes the largest independently observed assessment of animal welfare status carried out in the region of Galicia, in which 52 per cent of Spanish cattle farms are located, producing around 40 per cent of the overall Spanish milk yield. The assessment included only a limited number of aspects of dairy cow wellbeing in a commercial setting. Animal rearing and management (treatment and care along the day or attitude at the milking parlour), animal health status, nutritional value of feed (quality and quantity) and feeding management practices (uniformity of the feed ration mixture, frequency of ration delivery, frequency of feed pushes to the feed bunk, sorting by cows at the feed bunk, etc) equally affect the animal-based parameters measured during welfare status assessment. However, these measurements could not be included in this assessment for several reasons, that is, farmer consent (time spent on the farm, type of questions or copy of data records) and unavailability/unreliability of data records. The Welfare Quality Protocol could therefore not be applied and only common variables available across all sampling farms were considered.

Potential source of bias such as farmers consent to collect data on farm or the lack of keeping records could certainly affect results by decreasing variety and making a tight benchmarking process with few extreme values. Moreover, the hock injuries assessment was limited by the time spent on the farm impeding the classification by severity. And, a lack of the assessment over time has limited correlations, that is, lameness was previously related to reproduction failure and to decrease milk production.[29 30] Monitoring could not be done due to several management practices changes over time.

In this study, BCS was unsuitable in more than half of the cows in each herd and most cows were fat, as indicated by the criteria proposed by Coleen and Heinrichs.[9] The positive association between thin and fat cows within a herd may help to predict health-related problems and faulty management practices. Several management practices or facility designs (eg, overstocking, small front lunge space, feed bunk conditions, poor ventilation, found in this study) were previously reported to affect BCS by decreasing feed intake due to competition, limited feed bunk space, low feed quality (fermentations), decreased resting time and rumination, or heat stress conditions.[10 12]

The prevalence of hock lesions across farms observed in this study was lower than in other studies[15 31 32] in which prevalence rates of respectively 73.0 per cent, 60.5 per cent and 50.0 per cent were reported. However, it was not as low as the 16.3 per cent reported by Rutherford and others.[33] It is known that the use of poorly bedded mattresses greatly increases the risk of hock injuries.[31 34] Stall features that restrict the normal rising and lying down (eg, small stalls, presence of obstructions and hard lying surface) may aggravate the risk of lesions as cows try to adapt to restricted space.[13] In addition, concrete stalls or similarly hard surfaces are known to cause swollen knees resulting from impact as cows lie down,[35] suggesting that the development of hock injuries involves several aspects of facility design and management practices.

In free-stall systems, the link between stall design and lameness was most likely due to uncomfortable stalls resulting in cows spending more time standing;[36] however, the effect also depends on the nature of the surface on which the cows stand. Therefore, in this study several factors may contribute to lameness, including more than one factor at the time, for example, breed, several management practices such as nutrition, sharp turns near the parlour.[37–41]

The prevalence of lameness was lower than previously reported in studies carried out in Wisconsin (23.9 per cent),[37] Minnesota (24.6 per cent),[11] and the UK (36.8 per cent),[40] but not as low as the 5.1 per cent reported in Sweden.[42] This suggests the farms sampled in the present study were not outside of the normal range regarding other regions, although the status of Swedish farms should be considered an attainable target in relation to lameness.

Few studies have reported the prevalence of severe lameness (ranging from 6.0 per cent to 10.0 per cent prevalence) separately from clinical or overall lameness.[5 11 41] Severe lameness was lower in the present study than in those studies and, similarly to those studies, it accounted for only a small portion of clinical lameness (more cows scored 3 than 4 or 5). The positive correlation among clinical and severe lameness may suggest an evolution from low to severe scores instead of lameness prevalence decline.

The high prevalence of locomotion score 2, which is defined as imperfect locomotion but not diminishing the ability to move freely,[20] may predispose the cows to lameness if specific management practices do not change to improve the comfort of the cow. Imperfect locomotion may be caused by the lack of footbath protocols in most farms, especially in the study region where humidity levels reached higher than 80 per cent during the assessment period. Frequent use of footbaths is desirable to prevent proliferation of microorganisms and possible development of hoof problems. Furthermore, these issues may be aggravated by the presence of manure on the floor, and by a lack of cleaning practices and hoof trimming routines, as reported in this study.

The positive association among dirty cow's coat zones may help to identify common dirty areas or contamination across the three areas. The hygiene of the herd was previously reported to be mainly due to facility design, management practices or environmental conditions.[27 34 43] All these factors may influence cow behaviour and contribute to dirty coats caused by the cow lying down, splashing manure while walking or becoming contaminated via the tail while resting. Furthermore, Schreiner and Ruegg[26] showed linear effects of the cow hygiene on somatic cell scores. Therefore, the high prevalence of dirty udders could be considered a potential hazard in some of the farms evaluated in this study. The prevalence of dirty cows was high across the 73 farms, similarly to findings reported in other studies carried out in the UK[23] and Hungary,[44] especially regarding lower leg hygiene.

The high CCI found across the studied herds may indicate fertility and/or problems related to oestrus detection (low HD per cent). Moreover, factors affecting reproductive performance were previously associated either with management factors (eg, husbandry methods, feeding, oestrus detection, semen handling and transition cow management) or cow-dependent factors (ie, age, BCS, postparturition problems, diseases, milk yield and genetics)[45 46] which could apply to the present study.

The fact that the top-ranked and bottom-ranked farms had equal number of categories (A, B, C) assigned to different indicators suggested a wide range of variation in the management practices applied. Most farms did not display consistently good or poor animal-based welfare indicators and each farm had its own set of strong (indicators included in A category) and weak points (indicators included in C category). These results may explain the lack of correlation among different animal-based welfare indicators suggesting that many factors are involved in cow welfare. However, specific management practices may have a major influence on particular animal-based parameters and more research is needed to determine the potential that each factor has to influence cow welfare.

Most farms shared several problems concerning facilities design and management practices that may or may not affect the animal-based welfare indicators. However, the benchmarked top-ranked and bottom-ranked farms differed in some main critical points related to the high stocking density on the feed bunk and headlocks, lack of dryness of bedding materials, short front lunge space, lack of hoof trimming routine protocols, poor natural ventilation and poor facilities design of the milking area. Therefore, a specific improvement plan should be designed for each farm to increase performance and promote animal welfare.

One positive outcome of this field study was that individual farms were provided with a summary of the findings for their own and other farms in their region to allow benchmarking of their own performance. Each farm received a confidential report that could be used as a basis for discussion between owners and technicians. The authors' intention was to provide the farmers with an opportunity to make better informed decisions and develop tailored strategies for improving the care and management of cows on their farms.

Anecdotal feedback from participants has been positive; however, further research is required to assess how farmers use these data and whether benchmarking may result in changes of practices and sustained improvements of farms. Dairy farmers are generally concerned about the health and welfare of their animals, and, for instance, a sense of pride in a healthy herd has been identified as one of the most important motivators for lameness control.[47]

Benchmarking may provide information that is either reassuring (if herd performance is high) or helps to motivate change (if a major opportunity for improvement is identified). The authors' expectations were to find more severe cases of fat and lame cows; however this study suggested that many factors are involved in the cow wellbeing, and although environmental conditions of the Galicia region do not favour cleanliness, management practices may be a key control point. Therefore, farm assessments should consider management practices when establishing a benchmarking process across other farms.

CONCLUSION

On the basis of the study findings, the authors conclude that the animal welfare level was low on most farms and there were ample opportunities to make improvements regarding the different parameters assessed. Regarding animal-based observations, BCS was not optimal in most of the cows in the herd and the cows tended to be overweight. A high incidence of hock lesions and lameness was observed in all herds, although this did not impede the locomotion of cows (lesions of low severity). The hygiene of the cow's coat at the rear limb was deficient on all farms.

Regarding facility design and management practices, none of the farms performed consistently well or badly across parameters. Rather, a few critical points were identified in some farms and others had room for great improvement on several parameters.

All farms could benefit from benchmarking to prevent and control several aspects of animal welfare by changing management practices related to facilities and herds.

Acknowledgements The authors thank the veterinarians who participated in this study and also the farmers for their helpful collaboration in the study.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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