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Published online: 09 Mar 2016.

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Towards the creation of a welfare assessment system in intensive beef cattle farms

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ABSTRACT

This study aimed to develop an assessment scheme for the evaluation at farm level of beef cattle welfare in the intensive rearing system that is capable of both identifying weak points in animal welfare and grading farms to such extent. The basic principle of the method was the avoidance of animal handling and the prolonged observation of cattle using animal-based and resource provision measures grouped in four classes of parameters: 1) Housing systems and facilities; 2) Health and cleanliness; 3) Animal behaviour and reactivity; 4) Quality of management and stockmanship. Each parameter was graded giving the highest scores to the best option for animal welfare, and the threshold value for distinguishing good from poor welfare conditions was set primarily on the results of scientific reports and investigations.

An overall Welfare Index was calculated summing the scores of the 4 classes of parameters to formulate a general judgement of the farm and to allow comparison among them. The protocol was applied to 102 Italian intensive beef cattle farms rearing more than 300 young bulls/year. Regarding housing and facilities, the study showed that space allowance and space at the manger were the most frequent critical points. Within the "poor welfare" farms, more than 80% provided less than 3.5 m²/head to bulls weighing more than 500 kg, and none adopted a feeding frontage of at least 60 cm/head. Negatively judged farms compared to those ranked in the good welfare area for health and cleanliness showed a higher incidence of emergency slaughter (score 1.7: >1% *vs* score 3: 0.5-1%, P<0.05) and lameness (score 1.9: 1.5-3% *vs* score 3.3: <1.5%, P<0.05). Animal behaviour and reactivity parameters showed that in the "poor welfare" farms, bulls had a quicker flight reaction to the presence of both farmer and observer (P<0.01) likely due to a negative human-animal interaction. The quality of stockmanship was the category in which the highest number of farms failed to reach the acceptable threshold. Animal welfare was mainly impaired by the practice of tail docking and reduced feed availability. Although none of the farms included in the survey reached the maximum overall score, less then 30% were graded in the poor welfare area, penalized mainly by low management quality.

The protocol was shown to be effective in detecting specific critical points for animal welfare, even if further development should be addressed to testing repeatability at different fattening stages.

Key words: Beef cattle, Welfare, On-farm assessment.

RIASSUNTO
PROPOSTA DI UN SISTEMA DI VALUTAZIONE DEL BENESSERE DEL VITELLONE DA CARNE NELL'ALLEVAMENTO DI TIPO INTENSIVO

Il lavoro ha inteso sviluppare, per l'allevamento intensivo del bovino da carne, un sistema di valutazione a livello aziendale del benessere animale. Lo strumento si propone di individuare i punti critici e discriminare le aziende in relazione al livello di benessere offerto agli animali. Il protocollo di controllo è stato impostato in modo da evitare la manipolazione o prolungati periodi di osservazione degli animali anche se le rilevazioni hanno riguardato sia parametri riferiti agli animali sia all'ambiente di allevamento. Le misure considerate sono riconducibili a quattro classi: 1) Strutture di allevamento; 2) Stato di salute e pulizia; 3) Comportamento e reattività dell'animale; 4) Qualità della gestione e attitudine dell'allevatore. A ciascun parametro sono stati attribuiti dei punteggi assegnando il valore più elevato alla situazione più favorevole per il benessere animale. Per la creazione delle scale di valutazione sono stati utilizzati il report dell'Unione Europea sul benessere del bovino da carne e i risultati di specifiche ricerche scientifiche. Un indice sintetico di benessere (WI) è stato inoltre calcolato sommando i punteggi ottenuti in ciascuna classe allo scopo di formulare un giudizio di carattere generale dell'azienda e di compiere dei confronti tra le stesse. Il sistema di valutazione è stato applicato da un rilevatore addestrato ad un ampio campione di aziende intensive di bovini da carne della Pianura Padana (102) che allevavano più di 300 vitelloni da carne per anno.

Per quanto riguarda il capitolo delle strutture di allevamento lo studio ha evidenziato come la disponibilità di spazio per capo e la dimensione del fronte mangiatoia siano i principali punti critici di questa tipologia di aziende. In particolare più dell'80% degli allevamenti che ricadono nell'area dello scarso benessere mette a disposizione di vitelloni di peso superiore ai 500 kg meno di 3,5 m²/capo e nessuno di questi adotta uno spazio mangiatoia di almeno 60 cm/capo. Le aziende che hanno avuto una valutazione negativa per quanto riguarda la classe salute e pulizia degli animali evidenziano un'elevata incidenza di macellazioni d'urgenza (punteggio 1,7: >1% vs punteggio 3: 0,5-1%, P<0,05) e zoppie (punteggio 1,9: 1,5-3% vs punteggio 3,3: <1,5%, P<0,05) riconducibili principalmente alle carenze strutturali sopracitate. Comportamento e reattività degli animali mostrano che nelle aziende che offrono scarso benessere i vitelloni hanno una veloce reazione di fuga sia in presenza dell'allevatore che dell'osservatore (P<0,01) attribuibile probabilmente a un'interazione di tipo negativo tra uomo e animale. La qualità gestionale rappresenta la classe nella quale si registra il maggior numero di aziende che non raggiungono la soglia di accettabilità. Nello specifico il benessere animale sarebbe compromesso dalla pratica del taglio della coda e dalla ridotta disponibilità di alimento. Nessuna delle aziende considerata nel campione esaminato ha raggiunto il punteggio massimo di WI, anche se più del 70% delle stesse ricade nell'area di giudizio positivo. La maggior parte degli allevamenti collocati sotto la soglia di sufficienza sono stati principalmente penalizzati dalla scarsa qualità gestionale perciò la crescita del profilo professionale degli allevatori rappresenta una priorità sia per il miglioramento del benessere animali sia per incrementare la redditività aziendale.

Parole chiave: *Bovini da carne, Benessere, Sistemi di valutazione in allevamento.*

Introduction

Growing sensitivity to animal welfare and the increasing demand for a sustainable production system within European Countries has encouraged the entire productive chain to develop Quality Assurance Schemes that set production standards guaranteeing food hygiene, product traceability, and animal welfare (Webster *et al.*, 2004). Moreover, the EC policy on consumer protection is strongly addressed to developing certification systems along the entire production chain from "farm to fork", and animal welfare evaluation at farm level is one of the outstanding issues (European Commission, 2000).

Several animal welfare evaluation schemes have been developed so far with different purposes. Some have aimed at

identifying risk factors for welfare or grading farms on the basis of animal well-being status, while others had legislative or labelling implications (Botreau *et al.*, 2007). The development of welfare assessment protocols encounters three main difficulties: 1) the choice of reliable, feasible and repeatable parameters that truly reflect animal welfare (Winckler, 2006); 2) the construction of a grading system that could be a simple checklist (yes/no parameters), a sum of scores, or a sum of ranked or weighted scores for different measures; 3) the lack of defined benchmarks for several welfare evaluation variables.

According to Gonyou (1986), an assessing protocol should ideally be based on a multidisciplinary approach that considers animal-based parameters, such as productivity, behaviour, physiology, health, and immunity, as well as important society issues, such as environmental protection, economical effects, and food safety. Because the application of this type of approach to all categories of animal and every type of rearing system appears very complex (McGlone, 2001), different welfare evaluation systems have been proposed in literature. The Austrian ANI-system (Animal Needs Index) proposed by Bartussek (1999) that considers measures of provision of resources along with care and stockmanship quality has been applied to all categories of cattle, laying hens and pigs. A similar system, the TGI200 (Sundrum *et al.*, 1994), has been applied in Germany to certify welfare levels on organic dairy farms and scores seven different parameters: locomotion, feeding, social behaviour, resting, comfort, hygiene and stockmanship in an overall index. The system has been subsequently modified for application to beef cattle fattening units considering only the appropriateness of housing facilities (TGI40) (Sundrum and Rubelowski, 2001). Capdeville and Veissier (2001) proposed a method for dairy cattle considering the fulfil-

ment of animal needs as the basic principle for the judgement of animal welfare status. The Bristol Welfare Assurance Programme (BWAP) was addressed to the identification of animal welfare problems at the farm using specific standards based on the welfare legislation in force and/or welfare-relevant standards from scientific investigations (Main *et al.*, 2003) and is therefore suitable for updating whenever new knowledge or regulations become available.

The most relevant weak point of the ANI and TGI systems is their lack of animal-based measurements and human-animal relationship quality indicators. The methods proposed by Capdeville and Veissier (2001) and the Bristol Welfare Assurance Programme (BWAP), on the other hand, offer the advantage of including animal behaviour and health as welfare indicators.

This study aimed to develop a welfare assessment system capable of identifying the weak points in the rearing system that impair animal welfare and grading farms according to different levels of animal well-being through application to a wide sample of Italian intensive beef cattle farms. The evaluation protocol proposed and applied in this paper followed the basic principle of the above-mentioned TGI 200 system (Sundrum and Rubelowski, 2001) while adding, however, measures taken from direct animal observation that permit the monitoring of their adaptation to the rearing environment over time. Four classes of parameters: housing and facilities, animal health and cleanliness, behaviour and reactivity, and stockmanship and management quality were considered. Separate scores were adopted for each class in order to both help the assessor at advising farmers how to overcome specific weak points for animal welfare and limit the possibility of compensation for poor conditions in one class with a favourable score of another. An overall

welfare index was calculated for each farm by summing the parameter class scores in order to grade farms for potential animal welfare certification purposes.

Material and methods

Choice of parameters to be included in the assessment tool

Parameters included in the assessment tool were chosen by considering that they must:

- describe both housing system and management (design criteria) and animal response to the environment (animal-based criteria);
- be easily recordable under all field conditions by one observer and not invasive for animals (this postulate excludes physiological and immune system parameters);
- not be affected by specific situations that can change within short-time periods due to climatic or management related factors or those that are not serially-produced (such as growth performances that are not reliable welfare indicators due to the high variability within the farm in terms of breeds reared, slaughter weights, and feeding plans applied)
- have scores that can be set considering the animal welfare requirements proposed by official documents or previous scientific research
- lead to an immediate final judgement without requiring further laboratory investigation or remote data processing.

Check list description and scoring criteria

The check list featured 46 parameters grouped in four classes of welfare indicators:

- 16 parameters referred to housing systems and facilities (Table 1);
- 12 parameters considered hygiene and cleanliness of the barn along with animal cleanliness and health (Table 2);

- 13 parameters related to animal behaviour and reactivity (Table 3);
- 5 parameters evaluated management and stockmanship quality (Table 4).

Each parameter was graded by giving the highest scores to the best option for animal welfare considering the general principles contained in the European Convention for the Protection of Animals kept for Farming Purposes (Council of Europe, 1978). A threshold value to distinguish good from poor welfare conditions for each parameter was set at the point of accomplishment of fundamental needs according to EU beef cattle welfare report recommendations (EU-SCAHAW, 2001) and the results of previous scientific investigations, such as studies by Lensink *et al.* (2001a) and Lensink *et al.* (2001b) for animal reactivity, Cozzi and Gottardo (2005) for feeding and social behaviour, Cozzi *et al.* (2005) for animal cleanliness and Béranger (1986) for health status. The acceptability threshold scores are suitable for updating whenever new knowledge or regulations on the needs and minimum requirements for beef cattle welfare become available.

Summing acceptable and maximum scores of the parameters included within each class permitted the calculation of the acceptance threshold and the maximum reachable scores later expressed as percentage (Tables 1-4). Farms that failed to reach the threshold for a specific class of parameters were classified in the area of poor welfare.

An overall Welfare Index (WI) was calculated as the average of the scores reached in the four classes of parameters. The maximum WI was 100, while the acceptance threshold was set to 75.

Application of the protocol to the farm sample

Over a six month period, the scoring method was applied to 102 intensive beef cattle farms members of the Italian beef

Table 1. Parameters checked for the evaluation of housing systems and facilities and their scoring.

Items	Criteria of scoring	Minimum score	Maximum score	Threshold of acceptance
Space allowance	m^2/animal	1	4	3
Space at the manger	cm/animal	1	4	3
Drinking water availability	no. animals/waterer	1	4	3
Group size	no. animals/pen	1	3	2
Electrified grids	presence-absence	1	2	2
Handling facilities	absence-presence	1	2	1
Obstacles in the animals walk-way	presence-absence	1	2	2
Truck-loading facilities	absence-presence	1	2	1
Bedding on loading ramp	absence-presence	1	2	2
Lighting system	type of lighting	1	3	2
Night-time lighting	absence-presence	1	2	1
Environmental lightness	judgement of lightness level	1	3	2
Ventilation system	type of ventilation	1	2	1
Noisy environment	judgement of noise level	1	3	2
Quarantine pens	absence-presence	1	2	2
Sick bay	absence-presence	1	2	2
Total Score		16	42	31
Scores as percentage			100/100	74/100

producers' association (UNICARVE, Padova). All farms finished French pure breeds or crossbreed young bulls, mostly imported from France. The animals were housed in group pens either on slatted floor or deep bedding, and they were fed a total mixed ration (TMR) based on corn silage once a day.

The farm sample was divided in four classes according to the number of cattle reared on an annual basis (Table 5).

Data collection was always carried out by one trained observer following the same procedure. None of the measurements required handling or the prolonged observation of the animals.

Considering that different housing conditions might have been present within each farm, the checklist was applied to the farm's most representative stable in terms of animal weight (about 500 kg) and predominant pen type of floor. This decision was made briefly after interviewing the farmer upon arrival at the farm. The protocol was applied on five contiguous pens in the chosen stable and required about 5 hours starting in the morning one hour before cattle feeding.

Table 2.   Parameters checked for the evaluation of health and cleanliness and their scoring.

Items	Criteria of scoring	Minimum score	Maximum score	Threshold of acceptance
Animal cleanliness	judgement of cleanliness level	1	4	3
Barn cleanliness	judgement of cleanliness level	1	4	3
Unpleasant smell	judgement of smell level	1	3	2
Air ammonia	judgement of ammonia perception	1	3	2
Airing	judgement of air quality	1	3	2
Animals in sick bay	percentage	1	3	2
Emergency slaughter	percentage	1	4	3
Mortality	percentage	1	4	3
Tail necrosis	percentage	1	4	3
Orchitis	percentage	1	4	3
Bloating	percentage	1	4	3
Lameness	percentage	1	4	3
Total Score		12	44	32
Scores as percentage			100/100	73/100

Before TMR distribution (T0), the assessor evaluated:
- level of animal quietness (1=hypo-reactive, animals showed apathy and did not react by standing up when perceiving the presence of the farmer; 2= hyperactive, most of the animals stood up and frolicked; 3= normal reaction, about 50% of the animals stood up and performed activities such as grooming or exploring the environment;
- fearfulness of the animals towards the farmer and the unknown person (observer) assessed with the approach test and expressed as time of withdrawal (1=withdrawal within 5 seconds from the farmer/observer approach; 2=withdrawal in more than 5 seconds from the farmer/observer approach; 3=no animal reaction);
- assessment of feed residue at the man-

ger (1=empty manger or all manger surface broadly covered with old feed; 2=manger containing a small amount of orts; 3=all manger surface scarcely covered with feed)

Right after TMR delivery, the assessor:
- recorded the number of animals lying and standing at the manger with the scan sampling technique (5 scans with a 5 minute interval between scans)
- evaluated the occurrence of displacements within the pen-mates at the manger.

From the time of the distribution of the diet (T0) for the next three hours (T3), the observer:
- measured the facilities and evaluated the quality of the housing structures;
- evaluated the health status of the animals by counting the number of animals in the sick bay, the presence of tail

Table 3. Parameters checked for the evaluation of animal behaviour and reactivity and their scoring.

Items	Criteria of scoring	Minimum score	Maximum score	Threshold of acceptance
Observation carried out				
at feed delivery:				
Quietness	judgement of quietness	1	3	3
Flight reaction to farmer presence	time (seconds)	1	3	2
Flight reaction to unknown person	time (seconds)	1	3	2
Competition for feed	judgement of competition for feed	1	3	2
Eating	frequency	1	4	3
Lying	frequency	1	4	3
Observation carried out				
3 hours after feed delivery:				
Quietness	judgement of quietness	1	3	3
Flight reaction to farmer presence	time (seconds)	1	3	2
Flight reaction to unknown man	time (seconds)	1	3	2
Competition for feed	judgement of competition for feed	1	3	2
Eating	frequency	1	2	2
Lying	frequency	1	4	3
Ruminating	frequency	1	4	3
Total score		13	42	32
Scores as percentage			100/100	76/100

necrosis, lameness, orchitis and bloating in the whole herd reared in the stable observed;
- checked farm records in order to assess the incidence of mortality and emergency slaughtering;

Three hours after feed delivery (T3), the assessor evaluated again:
- the level of animal quietness;
- the fearfulness of the animals towards the farmer and the unknown person (observer) assessed with the approach test and expressed as time of withdrawal;
- the number of animals lying, ruminating and standing at the manger;
- aggressive interactions between penmates.

Data processing

Farm data were entered in a spreadsheet in order to calculate scores for each class of parameters and the overall WI. If the score was above the corresponding threshold of acceptance, the farm was grouped in the area of good welfare while if below in the area of poor welfare. Four separate statistical analy-

ses were then carried out within each indicator category (housing, cleanliness, behaviour and stockmanship) in order to identify the more penalizing parameters for the group of farms located in the poor welfare area. Data were processed by a linear model (SAS, 2001) considering farm size (no. of animals fattened/year) and farm welfare classification (good or poor welfare) as factors.

Results and discussion

Results will be presented by first considering the classification of the parameters surveyed and then making a general judgement on the strengths and weaknesses of the evaluation tool applied.

Farm traits
The cattle population of the entire farm sample was 114,593 heads and its distribution in 4 farm size classes is provided in Table 5. Small size units were the most frequent farm size (43) but raised only 16.7% of total cattle population. The number of very large farms was instead lower but they fattened more than 1/3 of the total beef cattle population.

Statistical analysis of the 46 welfare indicators never showed significant difference among the scores of the four classes adopted for farm size. Therefore this factor was not discussed in the text.

Housing systems and facilities
As shown in Table 6, seventeen farms did not reach the threshold of acceptability for inclusion in the good welfare area for the housing system and facilities class. Space allowance and space at the manger were the main critical points, even if neither parameter was fully satisfied even in the "good welfare" farms (Table 7). However, there was a clear and significant difference in the average scores obtained for such parameters that permitted to distinguish those that offered more comfortable housing from those that did not (Table 7). More than 80% of the "poor welfare" farms adopted a space allowance below the recommendation of 3.5 m²/head specified by EU-SCAHAW (2001) for bulls weighing more than 500 kg (Table 8). In the "good welfare" group, farms showed a significant improvement in terms of space allowance with more than 35% meeting the above-mentioned reference value (Table 8).

Table 4.   Parameters checked for the evaluation of management and stockmanship quality and their scoring.

Items	Criteria of scoring	Minimum score	Maximum score	Threshold of acceptance
Tail docking	yes-no	1	2	2
Animals regrouping	yes-no	1	2	2
Feed residue at the manger	amount	1	3	2
Diet chemical analysis	frequency of control	1	4	3
Willing to pay diet analysis	analysis payment	1	3	2
Total Score		5	14	11
Scores as percentage			100/100	78/100

Table 5. Classification of the farms surveyed on the number of animals reared per year basis.

Farm size	Number of animals reared per year	Number of farms	Number of animals	Percentage of the total population
Small	>300 -700	43	19080	16.7
Medium	>700 -1400	31	29977	26.2
Large	>1400 - 2100	14	22979	20.1
Very large	>2100	14	42557	37.1
Total		102	114593	100

Table 6. Farms classified according to "good" or "poor" animal welfare levels for the different classes of indicators and the Welfare Index.

	Farm classification	
	"good" welfare	"poor" welfare
Class of parameters	Number of farms	
Housing and facilities	85	17
Animal health and cleanliness	74	28
Animal behaviour and reactivity	71	31
Quality of the stockmanship	20	82
Welfare Index	72	30

The manger space data provided in Table 8 showed that none of the "poor welfare" farms offered the feeding frontage of 60 cm/head suggested by EU-SCAHAW (2001). Pen overcrowding is the consequence of insufficient space availability, which is detrimental to the behaviour, health and performance of beef cattle (Andersen *et al.*, 1997; Tuomisto *et al.*, 2006). Another consequence of overcrowding is increased competition for access to the waterers. Data obtained from our farm visits showed that about 50% of those scored negatively for housing and facilities had one waterer for more than 10 animals (Table 8) allowing in this way high ranking animals to block water access to subordinates. As for

dairy cattle in loose housing, drinking water requirements could be satisfied for all pen-mates by increased availability of waterers (Boxberger, 1983).

Regardless of positive or negative farm classification for housing and facilities, a generalized weak point for both animal welfare and farm worker safety was the absence of specialized truck-loading facilities (94% of the farms) and the lack of handling facilities (67% of the farms). The provision of these facilities has been shown to reduce stress to the animals caused by handling for routine examination, loading, and unloading on the lorry (Grandin, 1997). Another general weak point recognised by welfare

Table 7. Scores (least means) of "good" and "poor" animal welfare farms for housing and facilities class of parameters.

Items	Threshold of acceptance	Farms classification		RMSE	Significance
		"good" welfare	"poor" welfare		
Space allowance	3	2.9	1.7	0.32	*
Space at the manger	3	2.4	1.4	0.37	*
Drinking water availability	3	3.0	2.2	0.18	**
Group size	2	2.6	2.4	0.32	ns
Electrified grids	2	2.0	2.0	0.02	ns
Handling facilities	1	1.4	1.2	0.14	ns
Obstacles in the animals walk-way	2	1.6	1.6	0.29	ns
Truck-loading facilities	1	1.1	1.0	0.02	ns
Bedding on loading ramp	2	1.9	1.9	0.17	ns
Lighting system	2	2.9	2.7	0.38	ns
Night-time lighting	1	1.1	1.0	0.03	ns
Environmental lightness	2	2.3	2.0	0.33	ns
Ventilation system	1	1.5	1.3	0.28	ns
Noisy environment	2	3.0	3.0	0.03	ns
Quarantine pens	2	1.7	1.6	0.22	ns
Sick bay	2	2.0	2.0	0.03	ns

*ns: P>0.05; *: P<0.05; **: P<0.01.*

assessment was the insufficient attention paid by the farmer to biological safety, since over 30% of the farms had no special quarantine area for the isolation of incoming batches of bulls.

Health and cleanliness

The assessment of the farm's health and cleanliness class showed an increased number of "poor welfare" farms than the previous one (Table 6). The higher incidence of emergency slaughter and lameness, since their average scores were below the threshold of acceptability, mainly penalized farms negatively judged (Table 9). In the same group of farms, about 70% had a frequency of emergency slaughtering greater than 1% and a lameness incidence higher than 1.5% (Table 10) likely due to the insufficient space allowance assessed for more than half of these farms.

Barn cleanliness and ventilation mean scores were always above the threshold of acceptance (Table 9). However, the negatively judged farms had significantly lower scores than those in the good welfare area, underling their poor attitude at maintaining a neat environment for the animals.

Table 8. Distribution of the farms within different class of space allowance, space at the manger and drinking water availability.

Items	Score	Criteria of scoring	Farm classification	
			"good" welfare	"poor" welfare
			% of farms	
Space allowance	1	<2.5 m^2/head	5.9	52.9
	2	2.5 - 3 m^2/head	38.8	35.3
	3	3 - 3.5 m^2/head	20.0	5.9
	4	>3.5 m^2/head	35.3	5.9
Space at the manger	1	<50 cm/head	22.4	58.8
	2	51 - 60 cm/head	31.8	41.2
	3	61 - 70 cm/head	22.3	0.0
	4	>70 cm/head	23.5	0.0
Drinking water availability	1	>15 bulls/waterer	2.4	23.6
	2	11 - 15 bulls/waterer	11.8	23.5
	3	6 - 10 bulls/waterer	57.6	52.9
	4	<5 bulls/waterer	28.2	0.0

Animal behaviour and reactivity

Farm classification in the animal behaviour and reactivity class showed that 31/102 fattening units were judged in the poor welfare area (Table 6). In these farms, bulls had quicker flight reactions either to farmer or unknown person present at the time of diet distribution (Table 11). Because similar behavioural responses were observed three hours after diet delivery (Table 12), this can be ascribed to negative human-animal interaction (Lensink *et al.*, 2000). Moreover, the lowest mean scores for lying and eating frequency recorded before diet delivery in the "poor welfare" farms (Table 11) suggested that a high number of bulls were standing and waiting to be fed. This behaviour might have been due to both housing and stockmanship reasons. Indeed, over 70% of the negatively judged farms for this class of parameters had pens with narrow manger space (<60 cm/head), and due to an insufficient delivery, no residual feed was available in the trough before the daily distribution of the fresh diet. Gottardo *et al.*, (2004) showed how strongly inadequate manger space and insufficient feed can affect bulls' feeding behaviour and welfare. The depressed lying behaviour observed again three hours after feeding (Table 11) when bulls were supposed to be motivated to ruminate might suggest a lack in space allowance confirmed by the crosschecking of the data (less than 3 m^2/head in 77% of these farm sample).

Management and stockmanship quality

Management and stockmanship quality was by far the category in which the highest number of farms did not reach the acceptable threshold score (Table 6). Tail docking

Table 9. Scores (least means) of "good" and "poor" animal welfare farms for health and cleanliness class of parameters.

Items	Threshold of acceptance	Farm classification		RMSE	Significance
		"good" welfare	"poor" welfare		
Animal cleanliness	3	3.3	2.8	0.28	ns
Barn cleanliness	3	3.4	3.0	0.15	*
Unpleasant smell	2	2.2	2.1	0.16	ns
Air ammonia	2	2.4	2.2	0.15	ns
Airing	2	2.4	2.1	0.16	*
Animals in sick bay	2	3.0	2.7	0.17	ns
Emergency slaughter	3	3.0	1.7	0.46	*
Mortality	3	3.2	2.5	0.37	ns
Tail necrosis	3	3.7	3.2	0.25	ns
Orchitis	3	3.9	3.4	0.33	ns
Bloating	3	3.9	3.4	0.30	ns
Lameness	3	3.3	1.9	0.38	*

ns: $P>0.05$; *: $P<0.05$.

Table 10. Distribution of the farms within different class of barn cleanliness, airing, emergency slaughter and lameness.

Items	Score	Criteria of scoring	Farm classification	
			"good" welfare	"poor" welfare
			% of farms	
Barn cleanliness	1	very dirty	2.7	0.0
	2	dirty	0.0	17.9
	3	slightly dirty	56.8	71.4
	4	clean	40.5	10.7
Airing	1	weak	1.4	10.7
	2	adequate	59.4	71.4
	3	good	39.2	17.9
Emergency slaughter	1	>1.5%	8.1	50.0
	2	1 - 1.5%	13.5	17.8
	3	0.5 - 1%	52.7	28.6
	4	<0.5%	25.7	3.6
Lameness	1	>3%	5.4	32.1
	2	1.5 - 3%	14.9	42.9
	3	0.5 - 1.5%	29.7	21.4
	4	<0.5%	50.0	3.6

Table 11. Scores (least means) of "good" and "poor" animal welfare farms for animal behaviour and reactivity class of parameters.

Items	Threshold of acceptance	Farm classification		RMSE	Significance
		"good" welfare	"poor" welfare		
Observation carried out					
at feed delivery:					
Quietness	3	3.0	3.0	0.01	ns
Flight reaction to farmer presence	2	2.9	1.8	0.11	**
Flight reaction to unknown person	2	2.9	1.7	0.09	**
Competition for feed	2	2.8	2.4	0.35	ns
Eating	3	2.8	2.1	0.13	**
Lying	3	2.4	1.2	0.31	*
Observation carried out					
3 hours after feed delivery:					
Quietness	3	3.0	2.9	0.13	ns
Flight reaction to farmer presence	2	3.0	2.2	0.16	**
Flight reaction to unknown man	2	3.0	2.0	0.21	**
Competition for feed	2	2.9	2.3	0.30	ns
Eating	2	1.5	1.4	0.21	ns
Lying	3	3.0	2.1	0.32	*
Ruminating	3	2.5	2.2	0.27	ns

*ns: P>0.05; *:P< 0.05; **: P<0.01.*

and the above-mentioned lack of feed residue at the manger were the indicators that identified "poor welfare" farms. Tail docking of fattening cattle has been commonly used in the past as a preventive measure to reduce the incidence of tail necrosis (Busch and Kramer, 1995; Schrader *et al.*, 2001). We found bulls with this type of mutilation in 22% of the negatively judged farms, and not one such bull in the good welfare group (Table 14). Proper management decisions

such as the provision of a suitable feeding plan combined with adequate flooring and space allowance have been shown to reduce the incidence of tip necrosis avoiding tail docking (Metzner *et al.*, 1994).

Regardless of feed and diet chemical composition, which is not immediately assessable at farm level but important for correct ration formulation, critical points in feeding management were observed. The absence of feed residue in the manger 24 hours af-

Table 12.   Distribution of the farms within different class of animals' flight reaction to farmer and unknown person.

Items	Score	Criteria of scoring	Farm classification	
			"good" welfare	"poor" welfare
			% of farms	
Flight reaction to farmer presence at feed delivery	1	0 - 5 s	3.0	55.0
	2	>5 s	1.0	3.0
	3	no withdrawal	96.0	42.0
Flight reaction to unknown person at feed delivery	1	0 -5 s	1.4	61.3
	2	>5 s	2.8	3.2
	3	no withdrawal	95.8	35.5
Flight reaction to farmer presence 3 h after feed delivery	1	0 -5 s	0.0	42.0
	2	>5 s	1.4	3.2
	3	no withdrawal	98.6	54.8
Flight reaction to unknown person 3 h after feed delivery	1	0 - 5 s	1.4	51.6
	2	>5 s	1.4	3.2
	3	no withdrawal	97.2	45.2

ter diet delivery was observed in almost all "poor welfare" farms (Table 14). This condition does not guarantee the complete fulfilment of nutritional requirements by all pen-mates and leads to probable inhomogeneous growth among dominant and subordinate bulls. Another management practice with detrimental effects on beef cattle welfare is regrouping to homogenize the frame size of the pen-mates. Regrouping is a social stress source because it requires the establishment of a new hierarchy within the pen and can increase the risk of cross-contamination among pen-mates (Veissier *et al.*, 2001; Mounier *et al.*, 2005). Despite these clear scientific indications, 45/102 farms carried out regrouping and the frequency of this practice was not observed to be different in "poor" and "good welfare" farms.

Proper nutrition is fundamental in ensuring farm animal health and welfare (Albright and Stricklin, 1989), and therefore continuous awareness of feed and diet composition through routine analysis should play a key role in the successful management of any beef farm. Unfortunately, the scores obtained from diet analysis frequency assessment were disappointing in both groups of farms (Table 13).

Welfare index
Although none of the farms surveyed received the maximum WI score, more than 70% were ranked in the good welfare area (Table 6). Poor quality stockmanship was the class of parameters that penalized most of farms (93%) below the WI acceptance threshold, therefore the evaluation pro-

Table 13.   Scores (least means) of "good" and "poor" animal welfare farms for management and stockmanship quality class of parameters.

Items	Threshold of acceptance	Farm classification		RMSE	Significance
		"good" welfare	"poor" welfare		
Tail docking	2	2.0	1.8	0.06	*
Animals regrouping	2	1.5	1.5	0.35	ns
Feed residue at the manger	2	2.7	1.2	0.40	*
Diet chemical analysis	3	2.4	2.3	0.36	ns
Willing to pay diet analysis	2	2.5	1.9	0.28	ns

ns: P>0.05; *:P< 0.05.

Table 14.   Distribution of the farms within different class of tail docking and feed residue at the manger.

Items	Score	Criteria of scoring	Farm classification	
			"good" welfare	"poor" welfare
			% of farms	
Tail docking	1	yes	0	22
	2	no	100	78
Feed residue at the manger	1	empty manger	20	82
	2	manger containing a small amount of orts	0	5
	3	manger scarcely covered with feed	80	13

tocol should be used as a tool to raise the consciousness of farmers in the priority of improving their professional skills.

Strengths and weaknesses of the welfare evaluation protocol

The proposed beef cattle welfare assessment protocol has shown to be a useful tool in grading farms using a set of resource and not-invasive animal-based measures. Application to a wide sample of 102 intensive fattening units demonstrated its capability for discrimination of specific critical points regarding farm housing structures and stockmanship that affect animal health and behaviour.

The main strength of the protocol is the use of animal-based parameters as descriptors of the adaptation of the animal to the farm environment. The classes of parameters (health and cleanliness, and behaviour and reactivity) that include such type

of measures showed a farm distribution similar to that of the WI. Their normal distribution (Shapiro-Wilks Test: W>0.98) in a randomized sample choice supports the robustness of the evaluation protocol. Animal-based measures, therefore, seem to better describe the farm situation with regard to animal welfare conditions.

The feasible application of the protocol in half a day by a trained observer with a certain experience in beef cattle husbandry without any specific academic degree offers another advantage. Moreover, even if not adopted in the present study, once the protocol has identified the critical factors, the farmer can be easily advised how to improve the welfare of animals on the farm.

The principal weak point of the protocol regards its untested repeatability over time at different stages of the fattening period and among different observers, given that it was applied only once by a single observer.

Conclusions

One interesting outcome of assessment was the lack of any noticeable effect due to farm size, given that critical points were detected evenly in both small and large fattening units.

In many farms, decreasing the number of bulls per pen would be sufficient to improve cattle welfare and reduce the negative cas-cade on animal health and performance induced by overcrowding. Moreover, this solution is likely to increase farm income without any additional cost by reducing medical treatment and culling.

Farm assessment showed poor quality stockmanship to be a very common weak point. Beef farmers underestimate the direct and indirect losses created by incorrect feeding and management decisions or the onset of negative human-animal interaction. Producer associations, public extension services, and other farm advisors should therefore promote specific training courses for stockmen to improve their knowledge and skills in welfare-friendly farm practices.

Routine application of the protocol offers a promising tool for the improvement of beef cattle welfare and farm profitability, even more so whenever a welfare certification process becomes available. Further improvements in the assessment protocol should consider giving different weights to parameters or categories according to the degree of their effects on animal welfare.

REFERENCES

Albright, J.L., Stricklin, W.R., 1989. Recent developments in the provision for cattle welfare. Butterworth and Co. Publishers, London, UK.

Andersen, H.R., Jensen, L.R., Munksgaard, L., Ingvartsen, K.L., 1997. Influence of floor space allowance and access sites to feed trough on the production of calves and young bulls and on the carcass and meat quality of young bulls. Acta Agr. Scand. A-An. 47:48-56.

Bartussek, H., 1999. A review of the animal needs index (ANI) for the assessment of animals' well-being in the housing systems for Austrian proprietary products and legislation. Livest. Prod. Sci.61:179-192.

Béranger, C., 1986. Pathologie des jeunes bovins à l'engrais. In: D. Micol (ed.) Production de viande bovine. INRA Publ., Paris, France, pp 401-416.

Botreau, R., Bonde, M., Butterworth, A., Perny, P., Bracke, M.B.M., Capdeville, J., Veissier, I., 2007. Aggregation of measures to produce an overall assessment of animal welfare. Part 1: a review of existing methods. Animal 1:1179-1187.

Boxberger, J., 1983. Important aspects of cow behaviour as a basis for the improvement of cattle housing. Max-Eyth Agrotechnik Society ed., Berlin, Germany.

Busch, B., Kramer, S., 1995. Prophylactic tail docking in fattening bulls. Dtsch. Tierarztl. Wochenschr. 102:127-129.

Capdeville, J., Veissier, I., 2001. A method of assessing welfare in loose housed dairy cows at farm level, focusing on animal observations. Acta Agr. Scand. A-An. 51:62-68.

Council of Europe, 1978. European Convention for the Protection of Animals kept for Farming Purposes, 78/923/EEC. In: Official Journal, L 323, 17/11/1978, pp 14-22.

Cozzi, G., Gottardo, F., 2005. Feeding behaviour and diet selection of finishing limousin bulls under intensive rearing system. Appl. Anim. Behav. Sci. 91:181-192.

Cozzi, G., Ricci, R., Dorigo, M., Zanet, D., 2005. Growth performance, cleanliness and lameness of finishing charolais bulls housed in littered pens of different design. Ital. J. Anim. Sci. 4(suppl.2):251-253.

European Commission, 2000. White paper on food safety. Home page address: http://ec.europa.eu/dgs/health_consumer/library/pub/pub06_en.pdf

EU-SCAHAW, 2001. The Welfare of Cattle Kept for Beef Production. Home page address: http://europa.Eu.int/comm/food/fs/sc/scah/out54_en

Gonyou, H.W., 1986. Assessment of comfort and well-being in farm animals. J. Anim. Sci. 62:1796-1775.

Gottardo, F., Ricci, R., Preciso, S., Ravarotto, L., Cozzi, G., 2004. Effect of the manger space on welfare and meat quality of beef cattle. Livest. Prod. Sci. 89:277-285.

Grandin, T., 1997. Assessment of stress during handling and transport. J. Anim. Sci. 75:249-257.

Lensink, B.J., Boivin, X., Pradel, P., le Neindre, P., Veissier, I., 2000. Reducing veal calves' reactivity to people by providing additional human contact. J. Anim. Sci. 78:1213-1218.

Lensink, B.J., Fernandez, X., Cozzi, G., Florand, L., Veissier, I., 2001a. The influence of farmers' behavior on calves' reactions to transport and quality of veal meat. J. Anim. Sci. 79:642-652.

Lensink, B.J., Raussi, S., Boivin, X., Pyykkonen, M., Veissier, I., 2001b. Reactions of calves to handling depend on housing condition and previous experience with humans. Appl. Anim. Behav. Sci. 70:187-199.

Main, D.C.J., Kent, J.P., Wemelsfelder, F., Ofner, E., Tuyttens, F.A.M., 2003. Applications for methods of on-farm welfare assessment. Anim. Welfare 12:523-528.

McGlone, J.J., 2001. Farm animal welfare in the context of other society issues: Toward sustainable systems. Livest. Prod. Sci. 72:75-81.

Metzner, M., Hofmann, W., Heckert, H. P., Koberg, J., Raue, F., 1994. Epidemiology of inflammation of the tail tip in fattening bulls. Tierarztl. Umsch. 49:348-355.

Mounier, L., Veissier, I., Boissy, A., 2005. Behavior, physiology, and performance of bulls mixed at the onset of finishing to form uniform body weight groups. J. Anim. Sci. 83:1696-1704.

SAS, 2001. Statistical Analysis System User's Guide, version 8.2. SAS Institute, Cary, NC, USA.

Schrader, L., Roth, H.R., Winterling, C., Brodmann, N., Langhans, W., Geyer, H., Graf, B., 2001. The occurrence of tail tip alterations in fattening bulls kept under different husbandry conditions. Anim. Welfare 10:119-130.

Sundrum, A., Andersson, R., Postler G., 1994. Tiergerech-theitsindex 200, Ein Leitfaden zur Beurteilung von Haltungssystemen für Rinder, Kälber, Legehenen und Schweine. Verlag Köllen, Bonn, Germany.

Sundrum, A., Rubelowski, I., 2001. The meaningfulness of design criteria in relation to the mortality of fattening bulls. Acta Agr. Scand. A-An. 51:48-52.

Tuomisto, L., Ahola, L., Martiskainen, P., 2006. Effect of animal density, group size and pen floor mate-

rial on the growth and welfare of growing cattle - a literature review. Suom. Elainl. 112:635-641.

Veissier, I., Boissy, A., de Passille, A.M., Rushen, J., van Reenen, C.G., Roussel, S., Andanson, S., Pradel, P., 2001. Calves' responses to repeated social regrouping and relocation. J. Anim. Sci. 79:2580-2593.

Webster, A.J.F., Main, D.C.J., Whay, H.R., 2004. Welfare assessment: Indices from clinical observation. Anim. Welfare 13:S93-S98.

Winckler, C., 2006. On-farm welfare assessment in cattle from basic concepts to feasible assessment systems. pp 493-500 in Proc. 24th World Buiatrics Congr., Nice, France.