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Welfare assessment in intensive and semi-intensive dairy cattle management system in Sicily

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Abstract

The present study aimed to compare the welfare of dairy cows kept in two traditional husbandry systems (semi-intensive and intensive farming) in south-eastern Sicily. A total of 18 dairy farms (nine semi-intensive and nine intensive) were evaluated with a multicriteria system adapted for Sicilian conditions and obtained simplifying the model of the European Food Safety Authority (EFSA). Values of welfare measures, collected by inspections of the farms (general well-being indicators, ventilation system, resting areas [cubicles or bedding], flooring, milking parlours and waiting area, manger and watering equipment), and those of health categories (cases of abortions, hypocalcemia, displacement of abomasum, acidosis/ketosis, enteritis, hoof problems, and mastitis) obtained through the farm records, were compared using Mann–Whitney and Chi-squared tests, respectively. Data showed significant differences ($p \leq .05$) about the variables related to welfare categories such as housing ventilation system, resting area, manger, and water equipment that were better in the semi-intensive system than the intensive system. No significant differences were observed about the variables related to health indicators. The results demonstrated that in Sicily the semi-intensive farm is better than the intensive to satisfy the conditions of animal welfare.

KEYWORDS
animal welfare, dairy cow, intensive, pasture, production system

1 | INTRODUCTION

The Hyblean region of Sicily, located in the south-eastern province of Ragusa, is the largest milk-producing region in Sicily (Ferguson et al., 2007; Licitra et al., 1998). In 2019, milk deliveries in Sicily amounted to 199.182 tons of which 78.90% (157.173 tons) came from the province of Ragusa (CLAL, 2019). In this area, the dairy cattle farm has two main production systems. Generally, dairy cows are managed under the traditional system based on pasture (semi-intensive farming). In short, the semi-intensive system is characterized by access to pasture grazing for the provision of forage, during certain times of the day (for a minimum of 6 hr during daylight) from April 1 to October 31. A mechanically milking system is used.

In the largest herds of higher producing Holstein Friesian cows, dairy producers use a more specialized and intensive system is used where technical innovations for a more modern way of livestock breeding are used. Animals are housed in a free-stall system.

Feeding is done in the stables too and milking is carried out mechanically in milking parlors.

To improve and maintain access to competitive markets, the local industry is attempting to meet international quality standards such as traceability and safety aspects of the production system, environmental impact (Foley et al., 2011), and animal welfare. This latter point is especially an issue in international policy and business operations (Sullivan et al., 2017). Indeed, in recent years the European consumers increasingly demand high-quality livestock products (including milk) obtained with methods where animal welfare is also considered, and they are willing to pay a higher price for welfare-friendly products (EC DG SANTE & DG COMM, 2007, 2015). Consequently, the animals used for that purpose must be kept in welfare-friendly farming conditions (Broom, 2017; European Parlament, 2017; Lundmark et al., 2018).

For this reason, there is an increasing interest in assessing animal welfare at the farm level using welfare assessment systems (housing systems and management) such as the Animal Needs Index (ANI) in Austria and Germany (Bartussek et al., 2000) and the Bristol Welfare Assurance Programme (BWAP) in the United Kingdom (Leeb et al., 2004; Main et al., 2004).

More recently, various models have been developed for several livestock species (pigs, cattle, and poultry), that is, the Welfare Quality project (Botreau et al., 2009; Welfare Quality, 2009) where welfare measures are animal based (De Vries et al., 2011). The use of animal-based welfare indicators (e.g., example severity of lameness and mastitis in dairy cows) has been also implemented by European Food Safety Authority (EFSA) (EFSA, 2012, 2015).

Indeed, many farmers provide a comfortable environment for their animals with the aim to increase productions without diminishing their health status and well-being. For example, great effort has been made to improve cow facilities by introducing technology (Cozzi et al., 2008; Maga & Murray, 2010).

To support standards and technical recommendations of good practice for cow welfare and, consequently, performance on dairy farms, it is necessary to evaluate the effect of potential on-farm interventions.

Based on the above considerations, Authors report the results of an investigation in dairy farms in south-eastern Sicily considering two main farming systems of the territory: semi-intensive and intensive. The aim was to assess the husbandry conditions that may influence dairy cows' welfare and consequently productivity using a multicriteria evaluation obtained simplifying the model of EFSA.

2 | MATERIAL AND METHODS

2.1 | Ethics statement

The protocol of this study was carried out according to the standards recommended by the Guide for the Care and Use of Laboratory Animals and Directive 2010/63/EU and Italian and European rules on animal welfare.

The study was performed during the official sanitary routine inspection of the farms. In Italy, no authorization or protocol number is required. Giving that no handling and minimal disturbance of the cows occurred in this study, the work did not need approval by an ethics committee.

Before the assessment, the farmers were informed of the aim of the study and were assured that their identity would be kept confidential. Signed informed consent was obtained.

2.2 | Farms selection

A total of 18 farms of the province of Ragusa (Sicily, Italy), selected through breeders' associations and dairy farmers' organizations, as well as personal contacts, were assessed between April 2019 and October 2019. The farms were chosen based on their similar calving periods, the genetic background of the cows, and the same type of cheese production.

The farms were classified according to their pasture access: *Group A semi-intensive* ($n = 9$ dairy herds; Holstein Friesian and Alpine Brown cows) offering 7 months (from April 1 to October 31) of daily (6–10 hr) pasture access and *Group B intensive* ($n = 9$ dairy herds; Holstein Friesian and Alpine Brown cows) without access to pasture, utilizing an intensive system (Table 1).

2.3 | Welfare (W) protocol and data collection

To assess the farm dairy cattle welfare, a specific on-farm protocol (W protocol) was created based on the EFSA protocol (EFSA, 2009, 2012, 2015).

Modifications were made to shorten the protocol because of the need to fit observations during the official sanitary routine inspection of the farms.

The present study W protocol describes 26 on-farm welfare measures that are subdivided into six welfare categories: general well-being indicators, ventilation system, resting areas (cubicles or bedding), flooring, milking parlors and waiting area, and manger and watering equipment (Table A1).

The observations were carried out when the animals were indoor and within 1 hr after morning milking by three observers (FL, GM, and VB) with previous experience in dairy production and handling. To ensure that the observers applied the W protocol in a consistently and coherently, they had been trained in advance on how to use it.

About the "general well-being indicators", the human–animal relationship was evaluated from the interaction between stock persons and cows (Waiblingera et al., 2006), considering the animals' reaction (fear or confidence) to visual (presence of humans), tactile (moving between the animals with physical contact) and auditory stimuli (De Boyer des Roches et al., 2016; Lindahl et al., 2016).

TABLE 1 Overview of the 18 farms

Farm	N[a]	Farming system
A1	50	Semi-intensive
A2	90	Semi-intensive
A3	50	Semi-intensive
A4	50	Semi-intensive
A5	73	Semi-intensive
A6	72	Semi-intensive
A7	45	Semi-intensive
A8	40	Semi-intensive
A9	80	Semi-intensive
B1	250	Intensive
B2	180	Intensive
B3	130	Intensive
B4	260	Intensive
B5	145	Intensive
B6	350	Intensive
B7	186	Intensive
B8	510	Intensive
B9	260	Intensive

[a]Number of cows from each farm.

An accelerometer was applied to the hind leg of each cow using Vet-Wrap to record the time the cows spent lying down. The device was programed to record the position of the cow at 1-min intervals for 24 hr (Vasseur et al., 2012).

The "tails relaxed position" and its movements were classified as described by De Oliveira and Keeling (2018) as follows: hanging stationary, small wagging, direct wagging, vigorous wagging, and bent sideward.

In group A, all measures relating to "general well-being indicators" were assessed when the cows spent their time on pasture.

The dairy cows were observed three times at 10- to 15-day intervals always by the same operator to obtain a measure of repeatability.

All others measures are reported in the Table A1 that summarizes given scoring points. The points were been summed per category and totaled for the entire farm.

Health categories (cases of abortions, acidosis/ketosis, hypocalcemia, displacement of the abomasum, enteritis, hoof problems, and mastitis) and milk quality (somatic cell count and bacterial loads in the milk) were also considered. These measures were collected consulting farm records.

2.4 | Statistical analysis

The numerical measures of animal welfare (general well-being indicators, ventilation system, resting areas [cubicles or bedding], flooring, milking parlors and waiting area, and manger and watering equipment) were expressed as mean, standard deviations (S.D.), median, minimum, and maximum.

The categorical variables (cases of abortions, hypocalcemia, displacement of abomasum, acidosis/ketosis, enteritis, hoof problems, and mastitis) obtained from farm records were expressed as absolute frequencies and percentages. Examined variables were not normally distributed, such as verified by the Kolmogorov–Smirnov test; consequently, the nonparametric approach was used.

Comparisons were made using the Mann–Whitney test to evaluate the existence of possible significant differences between the scores obtained in the two groups for numerical parameters and the Chi-Squared test regarding categorical variables.

Radar graphs were realized to show and better visualize the differences between two groups (semi-intensive farming versus. intensive farming) about the means of obtained scoring points related to measures of animal welfare and to the statistically significant variables (not stress-dependent mooing, regular cubicles turn over, inadequate resting areas, behavioral indicators of fear when cow moves, and free access to feeding area in any moment).

p-values lower than.050 (two-sided) were considered statistically significant.

Statistical analyses were performed using the SPSS for Windows package, version 22.0.

3 | RESULTS

3.1 | Description of the study sample

The 18 herds included a total of 2,821 dairy cows.

The Group A herd size ranged from 40 to 90 (mean ± S.D.: 61.1 ± 17.7) with a mean of 39.8 ± 11.8 lactating cows and 129.66 ± 19.9 days open.

The Group B herd size ranged from 130 to 510 (mean ± S.D.: 252.3 ± 118.4) with a mean of 173 ± 102.3 lactating cows and 124.3 ± 15.1days open.

3.2 | Description of the distribution and qualitative assessment of the overall welfare scores and health measures

Table 2 comparatively shows the descriptive statistical animal welfare indicators (mean, standard deviation, and median) assessed in two different housing systems.

No statistically significant differences were observed between the two groups concerning "General well-being indicators" ($p = .407$).

For "housing ventilation system" there was a statistically significant difference ($p = .029$) between the two groups indicating better ventilation in semi-intensive system.

Relating to the category "resting area," the regular cubicles turnover was statistically significant ($p = .001$) higher in Group B than

TABLE 2 Qualitative assessment of the overall measures (mean ± *SD*, min., median, and max.) grouped in welfare categories in semi-intensive dairy cattle farm (Group A) versus intensive farm (Group B) and significance of difference between the two housing systems

Measures		Group A				Group B				*p*-value (A versus B)
		Mean (*SD*)	Min	Median	Max	Mean (*SD*)	Min	Median	Max	
General well-being indicators		13.6 (0.7)	13	14	15	13.1 (1.4)	11	13	14	Ns
Housing ventilation system		18.3 (0.7)	17	18	19	17.3 (1.3)	16	18	18	.029
Resting areas	Cubicles	0	0	0	0	11.3 (3.1)	12	13	15	.001
	Bedding	13.6 (0.8)	13	11	15	1.8 (5.1)	0	0	13	.007
Flooring		3.2 (0.3)	1	3	5	3.5 (0.4)	2	3	4	Ns
Milking parlors and waiting area		8.1 (0.6)	6	8	9	7.8 (1.1)	5	9	10	Ns
Manger and watering equipment		14.2 (0.4)	14	15	15	14 (1.2)	12	14	15	.016
Total		72.2 (2.6)	64	69	78	68.8 (2.7)	58	70	89	.031

Abbreviations: Max., maximum; Min., minimum; Ns, not significant ($p \geq .05$); *SD*, standard deviation.

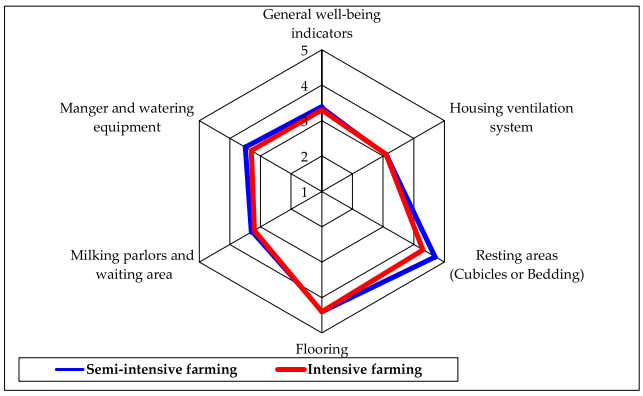

FIGURE 1 Comparison between semi-extensive and intensive farming concerning general comfort indicators of dairy cows

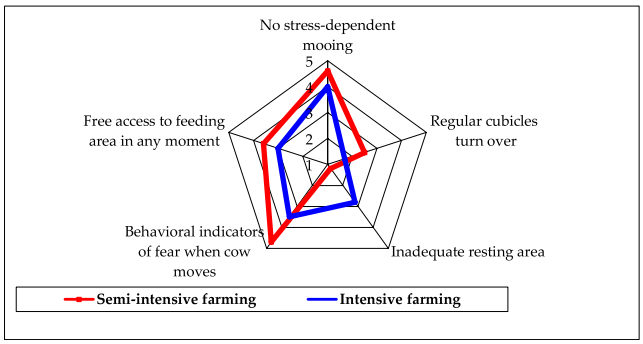

FIGURE 2 Comparison between semi-extensive and intensive farming concerning dairy cow welfare indicators resulted statistically significant from the assessment carried out

Group A. The bedding appeared statistically significant ($p = .006$) higher in Group A than B.

The flooring did not appear significant ($p = .774$), probably a result of the gradual spreading of nonslip scree that allows animals to move easily.

No significance was attributed to categories such as "milking parlor and waiting room" ($p = .334$).

The category relating to "mangers and water equipment" was significantly higher ($p = .016$) in Group A than B about to free access to food for all cows at all times.

Radar graphs (Figures 1 and 2) show that scores of Group A were higher than Group B ($p = .048$), from which it is easy to understand that semi-intensive farming creates more satisfactory conditions for dairy cows' welfare.

A total of 2,821 records (Group A = 550; Group B = 2,271) were examined. The analysis of records (Table 3) showed that cows of Group B presented an extending of days open, a higher percentage of acidosis/ketosis, as well as the cases of hypocalcemia, abomasum dislocation, enteritis, and mastitis, although there was no statistical difference in general herd health indicators between the Group A and the Group B.

Table 4 shows the results relating to milk quality indicators. The increase in the somatic cell in the milk from Group B was statistically significant ($p = .011$), although in both groups it was fully within the limits provided by the European regulations (European Parliament & of the Council, 2004).

4 | DISCUSSION

This study was aimed to assess the effect of two different dairy farm systems typical of Ragusa's province on welfare indicators using a W protocol. This study provides information on the management practices in two different dairy farm systems typical of Ragusa's province, Sicily.

Firstly, a limitation of the study was given by the fact that some measures such as "lying time" were assessed in different environments (barn and pasture). Despite this, the observation of the associated measures followed the procedure of the W protocol to ensure comparability, as reported by Armbrecht et al., (2019).

TABLE 3 Distribution of categorical (no. (%)) variables (health indicators) recorded in semi-intensive dairy cattle farm (Group A) and intensive farm (Group B)

Health Measures	Group A	Group B	*p*-value (A versus B)
Abortions	29/550 (5.2%)	151/2,271 (6.6%)	Ns
Hypocalcaemia	10/550 (2%)	50/2,271 (2.2%)	Ns
Displacement of abomasum	2/550 (0.3%)	13/2,271 (0.6%)	Ns
Acidosis/ketosis[a]	15/550 (2.7%)	88/2,271 (3.9%)	Ns
Enteritis cases	10/550 (1.8%)	66/2,271 (2.9%)	Ns
Hoof problems	8/550 (1.6%)	71/2,271 (3.1%)	Ns
Mastitis cases	27/550 (4.9%)	141/2,271 (6.2%)	Ns

Abbreviation: Ns, not significant ($p \geq .05$).

[a]In the first 3 months of milking.

TABLE 4 Qualitative assessment of the overall measures (mean ± *SD*, min., median, and max.) grouped in term of milk quality in semi-intensive dairy cattle farm (Group A) versus intensive farm (Group B)

	Group A				Group B				
Measures	Mean (*SD*)	Min	Median	Max	Mean (*SD*)	Min	Median	Max	*p*-value (A versus B)
Somatic cell (10^3/ml)	310.2 (265.5)	200	230	1,000	600 (273.4)	400	628.9	1,100	.048
Bacteria load (10^3/ml)	29.3 (38.4)	25	16	130	32.9 (37.4)	10	20	130	Ns

Abbreviation: Ns, not significant ($p \geq .05$).

Lying down and resting are both fundamental activities for dairy cows to maintain good health, welfare and high-levels of productivity (Tucker et al., 2004).

The time in which the cows needed to lay down was measured in the same way, regardless of whether the cows were indoor or on pasture. Although cows at pasture had more ample and comfortable space available and consequently lying condition might seem to be more appropriate on pasture than in cubicles, there was not observed differences between the two groups.

Concerning the category "resting area," better scores for comfort around resting for the group-housed indoor were attributed to adequate and clean area in cubicles and poor collisions with the housing equipment during lying down.

The desire of the cows to lie down is influenced also by the hygiene of the resting surfaces; in fact, they prefer the clean, dry, and soft surfaces for resting (Rushen et al., 2007).

Nevertheless, it was signaled the presence of wet knee and dirty lower legs and udders in cows of group B, even if a limited number. This aspect is very important because could result in a high risk of mastitis and worsening of lameness (Cook, 2002; Reneau et al., 2005). The dirtiness of these body regions observed in this study was caused occasionally by a poor change of bedding.

The scores for the category "manger and watering equipment" have highlighted that in general there was free access to food for all cows at all times.

As regards water requirements in dairy cows, these were satisfied by the use of automatic on-demand watering systems that deliver water when an animal requires it, in both systems, thus preserving its freshness and hygiene.

It is well known that easy access to food, on grazing or feeding areas, results in a greater amount of ingested dry matter, as well as increased milk production and a lower incidence of traumas (Costa et al., 2018). A manger with a self-locking feed barrier or an incorrectly positioned neck rail can lead to a limitation of the animals' movements with a consequent increase in intraspecific competition (Tucker et al., 2005).

Also cows reared in semi-intensive farming could in such conditions produce higher quality milk from which the best-processed milk products are made.

In general, as suggested by several Authors (Arnott et al., 2017; Krohn, 1994), pasture access improves dairy cattle welfare because it provides a natural environment where cows can express behaviors such as grazing and exploring and can walk freely, bringing benefits to their health (Regula et al., 2004).

The state of greater welfare of the dairy cows in Group A is partially a consequence linked to the management of animals on pasture, in which the presence of pathogenic agents is neglectable compared with the tethering housing system.

An important aspect of animal health is a higher level of acidosis/ketosis, as well as hypocalcemia, displacement of abomasum, enteritis, and mastitis in the confined cows compared to the pasture cows, although no significant differences were observed. Relating to mastitis, these results are confirmed by other studies (Bendixen et al., 1986, 1988; Washburn et al., 2002) where it was possible to

observe that confined Holstein cows had an increased prevalence of mastitis compared to the pasture cows. The lower levels of mastitis in pastured cows could be due to fewer environmental pathogens' exposition compared with confinement-housed cows (Washburn et al., 2002).

The low frequency of hoof problems (1.6%) in pasture cows, and as well as in confined cows (3.1%), was unexpected. It may be explained by the higher attention paid by farmers to the less demanding yields characterizing small-scale systems in Sicily, with a consequent reduction of productivity-related clinical conditions, as highlighted by other Authors (Oltenacu & Broom, 2010).

5 | CONCLUSIONS

This finding suggests that the use of pasture could be considered a positive management aspect for cow welfare as reported in other studies (Armbrecht et al., 2019; Schuppli et al., 2014).

This study highlights the need for significant environmental, management, and husbandry changes for farmers to comply with current European and Italian legislation prescribing better welfare practices.

In fact, in the cases in which it is chosen an intensive system, a better level of welfare could be achieved if—following the EFSA report (EFSA, 2009)—the animals are given pasture access at least during summer or dry weather.

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CONFLICT OF INTEREST

The authors declare no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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TABLE A1 Parameters considered for each farm with details criteria and scoring points

Categories	Measures	Points	Standard points	References
General well-being indicators	Good human–animal relationship	1–5	1 = Cows show fear to visualize of the farmer and/or stockpersons 2 = Cows do not recognize the farmer and/or stockpersons (no fear signals may be detected) 3 = Cows recognize the farmer and/or stockpersons 4 = Cow is confident to farmer and/or stockpersons 5 = The cow is very confident to farmer and/or stockpersons (sensitives to tactile stimuli)	Lindahl et al., (2016). De Boyer des Roches et al., (2016)
	Lying time	1–5	1 = < 6 hr/die 2 = 6–8 hr/die 3 = 9–12 hr/die 4 = 13–16 hr/die 5 = > 16 hr/die	Vasseur et al., (2012)
	Tails relaxed position	1–5	1 = Hanging stationary 2 = Small wagging 3 = Direct wagging 4 = Vigorous wagging 5 = Bent sideward	De Oliveira and Keeling (2018)
	TOTAL		15	
Ventilation system	Windy air and low NH3 concentrations	1–3	1 = Very poor 2 = Poor 3 = Satisfactory	
	Feces exempted of sour smell	1	1 = Presence of sour smell	
	Cough, nasal, ocular and conjunctival discharge, breath problems	1–2	1 = Present 2 = Absent	
	Spiderwebs	1	1 = Absent	
	Condensation in the ceiling	1–2	1 = Present 2 = Absent	
	Internal *T*°< 4–5°C to external *T*°(summer)	1–4	1 = Internal *T*°< 4–5°C to external *T*° 2 = Internal *T*°> 5–10°C to external *T*° 3 = Internal *T*°>10–15°C to external *T*° 4 = > 15°C	
	Internal *T*° > 3–4°C to external *T*°(winter)	1–4	1 =°>3–4°C to external *T*°(summer) 2 = Internal *T*° > 5–10°C to external *T*° 3 = Internal *T*°>10–15°C to external T° 4 = > 15°C	
	Wet coat	1	1 = absence of wet coat	
	Regular cubicles turnover	1–2	1 = Poor regular 2 = Very regular	
	TOTAL		20	
Resting areas				
Cubicles	Inadequate resting area (more than 15% of standing cows are presented)	1–5	1 = More than 15% of standing cows are presented 2 = More than 10%–15% of standing cows are presented 3 = More than 5%–10% of standing cows are presented 4 = Less than < 5% of standing cows are presented 5 = No standing cows are presented	
	Hock, skin and limbs lesions.	1–5	1 = Major swelling (≥2.5 cm); may have bald area or break in skin 2 = Moderate swelling (>1 to < 2.5 cm) or break in skin or scab present 3 = Bald area or minor swelling (<1 cm) 4 = No swelling, no missing hair; some broken hairs present 5 = Absent	Jewell et al., (2019)

(Continues)

TABLE A1 (Continued)

Categories	Measures	Points	Standard points	References
	Colliding with housing equipment during lying down	1–5	1 = Very present 2 = Present 3 = Poor present 4 = Very poor present 5 = Absent	
Or				
Bedding	Knee test (no swelling)	1–5	1 = No swelling; 2 = swelling <1 cm 3 = Swelling 1–2.5 cm 4 = Swelling >2.5 cm 5 = Swelling >2.5 cm with bald area, broken skin or scab	Gibbons et al., (2012)
	Sharp edges, ditches and heaps	1–5	1 = Very resent 2 = Present 3 = Poor present 4 = Very poor present 5 = Absent	
	Cleanliness of udder, tail and hint limbs	1–5	1 = Area completely covered with dirt 2 = Large dirty parts covering more than half the area 3 = Large dirty parts covering less than half the area 4 = Some small dirty parts 5 = No dirt	Veissier et al., (2004)
	TOTAL		15	
Flooring	No-slipping furrows, bores or grooves	1–5	1 = Absent 2 = Very poor present 3 = Poor present 4 = Present 5 = Very present	
	TOTAL		5	
Milking parlors and waiting area	Waiting times	1–4	1 = Waiting times > 2 hr 2 = Waiting times > 1 hr and < 2 hr 3 = Waiting times > 30 min and < 1 hr 4 = Waiting times < 30 min	
	60% of cows has ruminant activity at this time	1–3	1 = Absent 2 = Present 3 = Very present	
	Cows do not collide and kicked	1–3	1 = Absent 2 = Present 3 = Very present	
	TOTAL		10	
Manger and watering equipment	Cows don't kneel when eat	1–3	1 = Absent 2 = Poor present 3 = Present	
	Colliding with feed rack	1–4	1 = Very present 2 = Present 3 = Poor present 4 = Absent	
	Easy access to watering equipment after milking	1–4	1 = Absent 2 = Poor present 3 = Present 4 = Very present	
	Free access to feeding area in any moment	1–4	1 = Absent 2 = Poor present 3 = Present 4 = Very present	
	TOTAL		15	
	TOTAL AMOUNT		80	