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# Animal welfare and reproductive performance in two Piemontese housing systems

Lara Irico[a], Laura Tomassone[b], Giuseppe Martano[c], Flaviana Gottardo[d] and Martina Tarantola[b]

[a]Veterinary Practitioner, Torino, Italy; [b]Dipartimento di Scienze Veterinarie, University of Torino, Torino, Italy; [c]ASL TO3, Animal Health, Torino, Italy; [d]Dipartimento di Medicina Animale, Produzione e Salute, University of Padova, Padova, Italy

**ABSTRACT**

Tie-stall and loose housing are the main housing systems adopted in Piemontese cattle farms in Piedmont Region (North Western Italy). In this study, we used the ANI35/L2000 index to assess the cattle welfare in both types of housing systems, by studying 56 farms. Within each housing system, farms were classified as 'low', 'sufficient' or 'good' welfare farms, according to the score obtained, and this score was associated with reproductive parameters of cows. A higher welfare score was obtained in loose housing farms. Calving intervals and annual calf to cow ratio showed significantly better values in the loose housing system compared to tie stalls. Within tie stalls system, better reproductive performance has been recorded in farms with a higher welfare classification.

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Cow; housing system; ANI 35; reproductive parameters; welfare

## Introduction and materials and methods

Italy is one of the main European beef cattle producer countries, with more of 130,000 beef cattle farms, about 12,000 of which located in North Western Italy.

Loose-housing and more commonly tie-stalls are the main housing systems adopted in Piemontese cattle farms. Producers adopting only tie-stall barns are often traditional, small family farms, characterised by scarce productivity-enhancing technologies. Tie stalls system is criticised because it prevents the animals to express normal behaviour (Mattiello et al. 2005; Popescu et al. 2013). In addition, it has been demonstrated that cortisol level is higher in tie-stall than in loose housing system (Starvaggi Cucuzza et al. 2014; Tarantola et al. 2016).

The mobilisation of the scientific community, incentivised by public opinion about the need to maintain acceptable and ethical conditions for livestock, permitted to issue many rules of law and investments aimed to animal protection, but no specific legislation referring to the welfare of beef older than six months is available.

Scoring systems considering environmental and housing parameters have been implemented during the last years (Mazurek et al. 2010) for the assessment of animal welfare in calves, dairy and beef cattle. These indirect methods allow to carry out welfare evaluations without cattle restraint, and attribute a welfare score through environment-based measures (Johnsen et al. 2001).

In Austria and Germany, an animal needs index (Austrian Animal Needs Index) was initially developed by Bartussek (1985), and a new, definitive, version (ANI35/L2000) was issued in 2000 (Bartussek 2000). The latest is recommended for cows, young and beef cattle from 7 month of age. It assesses animal welfare through the evaluation of housing conditions on the basis of what is known to be important for meeting the animals' needs and ensuring their well-being. It gives a total score; the higher the ANI score, the better the fulfilment of animal needs is. The ANI35 system became an official method to assess animal welfare level in organic Austrian farms.

In our study, the ANI35/L2000 method was used to evaluate the two main housing systems for Piemontese cows in Piedmont Region, the tie-stall and the loose housing. In addition, we assessed the association of the welfare scores with some reproductive parameters of cows, as suggested by Valde et al. (1997), considering that they are sensible stress indicators and a reliable index for animal well-being.

CONTACT Dr. Martina Tarantola martina.tarantola@unito.it Dipartimento di Scienze Veterinarie, Università di Torino, L.go Braccini, 2, 10095 Grugliasco, Torino, Italy

### Animals and housing

A total of 56 Piemontese cow farms, certified by Anaborapi (*Associazione degli Allevatori della Razza Bovina Piemontese*), were randomly chosen in the area of Turin and Asti Province of the Piedmont Region. Only farms with more than 20 animals were selected. Thirty farms adopted a traditional tie-stall housing system, in which animals were usually kept in two rows of single tie-stalls facing each other and divided by a feeding alley. The stall surface was a concrete floor covered with straw. The animals were fed in the stall twice a day and had free access to drinker bowls; the only movement possible was lying down and standing. The remaining 26 farms had loose-housing system: the animals were kept in multiple pens (4–6 animals per pen) with open areas of about 3 $m^2$ of free surface for each cow. The animals had free access to water troughs (nine cows per trough) and a central feeding alley. Only two farms housed animals on straw bedding, whereas in the remaining farms the cows were on slatted floor.

## Data collection

The farms were visited once, in the period January–June by two expert evaluators, who examined together each of the farms in about one hour and half.

### Welfare assessment

Scores (from −0.5 to +3) were attributed to each item within the five evaluation categories of the ANI35L/2000 method (Bartussek 2000): locomotion and space allowance; social interaction; type and condition of flooring; light and air conditions; stockmanship. The five scores were summed to give a total welfare score ranging between –9 and +45.5 points.

### Reproductive parameters

In each farm, data on reproductive parameters were collected: calving interval (days), calf to cow ratio per year, number of services per conception, mean of pregnancy to cow ratio, cattle culling (%) and age at culling. Data were extracted from the annual report elaborated by Anaborapi in 2015.

### Statistical analysis

Data were analysed by R software (R Development Core Team 2015). Median and quartiles (Q1–Q3) were used to describe the welfare scores. Considering the first and the third score quartiles of the total welfare score, farms of both housing systems were categorised in three subgroups: 'good' (>19.9 in tie-stall vs >39.9 in loose-housing farms), 'sufficient' (11.5–19.9 vs 24.6–39.9) and 'low' welfare (<19.9 vs <24.6). Non-parametric tests (Wilcoxon's rank sum test and Kruskal–Wallis's test) were used to evaluate differences in welfare scores between the two housing systems and to evaluate their association with reproductive parameters. ANOVA was carried out to evaluate the differences among continuous reproductive parameters in welfare groups; Bonferroni was used as post hoc test. The results were considered statistically significant when $p < .05$.

## Results and discussion

The 56 analysed farms had a mean animal number of 62.6 (standard deviation, SD: 40.8), with the tie-stalls farms being on average smaller than those with loose-housing (45.3 ± 16.6 vs 82.7 ± 50.6 animals).

The ANI35L/2000 median score for all farms was 29.8 (Q1–Q3: 15.5–31.5). The median score of the five categories, all important factors for the health and welfare of cattle were: 4.0 for 'Locomotion and Space allowance' (Q1–Q3: 2.0–6.8); 4.3 for 'Social interaction' (Q1–Q3: 1.5–7.5); 4.5 for 'Type and condition of flooring' (Q1–Q3: 3.5–5.5); 4.0 for 'Light and air conditions' (Q1–Q3: 2.0–6.6); 5 for 'Stockmanship' (Q1–Q3: 3.5–6.0).

We registered significantly higher scores in the loose-housing farms compared to tie-stall for four of the five evaluation categories (and for the total score): 'Locomotion and Space allowance' (7.5 vs 2.0; $p < .001$), 'Social Interaction' (7.5 vs 1.5; $p < .001$), 'Type and condition of flooring' (5.0 vs 4.0; $p = .013$) and 'Light and Air Conditions' (6.5 vs 3.2; $p < .001$).

Welfare scores of the five categories significantly differ between the two housing systems (Table 1).

We also compared the welfare scores among subgroups in each farm system. In tie-stalls, it was observed a statistically significant difference in all five evaluation categories; in particular, highly significant differences were found for scores of 'Locomotion', 'Social Interaction', 'Light and Air Conditions' and 'Management' categories ($p < .001$). Accordingly, we recorded a significant difference among all subgroup scores in the loose-housing farms, with a higher evidence for the 'Locomotion', 'Social Interaction' and 'Light and Air Conditions' scores ($p < .001$).

Our results may be due to the greater amount of space available for animals in the loose-housing farms

**Table 1.** Welfare score in tie-stall and loose-housing farms welfare subgroups ($n = 56$).

| | Tie-stall farms Score median value (Q1–Q3) | | | Loose-housing farms Score median value (Q1–Q3) | | | |
|---|---|---|---|---|---|---|---|
| Categories | Good | Sufficient | Low | Good | Sufficient | Low | $p$ Value (difference between tie-stall and loose-housing farms) |
| Locomotion | 4.5 (2–6.25) | 2 (2–2) | 1 (1–1.5) | 9 (9–10.5) | 7.5 (6–8) | 4 (3.25–4.75) | <.001 |
| Social Interaction | 3.25 (1.5–5.5) | 1.5 (1.5–1.5) | 1 (1–1.5) | 8 (8–9) | 7.5 (5.4–8) | 5 (4.5–7) | <.001 |
| Type and condition of flooring | 5.5 (5.4–6.1) | 4 (3.5–4.5) | 3.5 (3.5–3.5) | 6.5 (5.7–6.7) | 5 (4.9–5.6) | 3.25 (3.2–4.2) | <.001 |
| Light and air condition | 5.5 (4.5–7) | 3 (3–4) | 1.5 (1.5–2) | 8.5 (7–8.7) | 6.75 (6.1–7.6) | 2 (2–2.5) | <.001 |
| Stockmanship | 6.25 (5.4–7) | 4 (4–5.5) | 2 (2–3) | 6.25 (5.8–6.5) | 5 (3.5–6.1) | 3.5 (2.8–4.2) | <.001 |

**Table 2.** Descriptive analysis of selected reproductive parameters of Piemontese cattle in tie-stall and loose-housing system in Piedmont region ($n = 56$).

| Farm system and reproductive parameters | | Calving interval (days) | Calf to cow ratio per year | No. of services per conception | Mean of pregnancy to cow ratio | Age at culling | Cattle culling, % |
|---|---|---|---|---|---|---|---|
| All farms | Mean ± SD | 404.5 ± 43.2 | 0.89 ± 0.1 | 1.86 ± 0.7 | 3.99 ± 0.79 | 103.9 ± 33.3 | 14.4 ± 8.5 |
| | Median (Q1–Q3) | 400 (367.5–429.5) | 0.88 (0.8–0.95) | 1.7 (1.5–2.1) | 3.9 (3.4–4.6) | 101 (83.5–128.0) | 13 (8.5–17.5) |
| | Min–Max | 338–548 | 0.67–1.1 | 1–3.8 | 2.4–5.4 | 27–178 | 2–40 |
| Tie-stall farms | Mean ± SD | 420.9 ± 47.4[a] | 0.9 ± 0.1[a] | 2.0 ± 0.74 | 3.8 ± 0.7 | 101 ± 36.6 | 15.3 ± 8.5 |
| | Median (Q1–Q3) | 419 (391.0–450.5) | 0.86 (0.79–0.93) | 1.7 (1.5–2.4) | 3.85 (3.3–4.3) | 98 (77.0–129.0) | 13 (10.0–17.0) |
| | Min–Max | 338–548 | 0.67–1.1 | 1–3.8 | 2.4–5.1 | 27–178 | 3–38 |
| Loose- housing farms | Mean ± SD | 385.5 ± 28.2[b] | 0.9 ± 0.08[b] | 1.7 ± 0.6 | 4.1 ± 0.8 | 107.2 ± 29.5 | 13.3 ± 8.4 |
| | Median (Q1–Q3) | 385.5 (364.3–404.3) | 0.91 (0.9–1.0) | 1.65 (1.3–2.0) | 3.95 (3.5–4.9) | 108.5 (87.8–126.8) | 11.5 (7.3–17.8) |
| | Min–Max | 339–448 | 0.75–1.08 | 1–3.6 | 2.8–5.4 | 42–162 | 2–40 |

[a,b]Significantly different ($p < .05$).

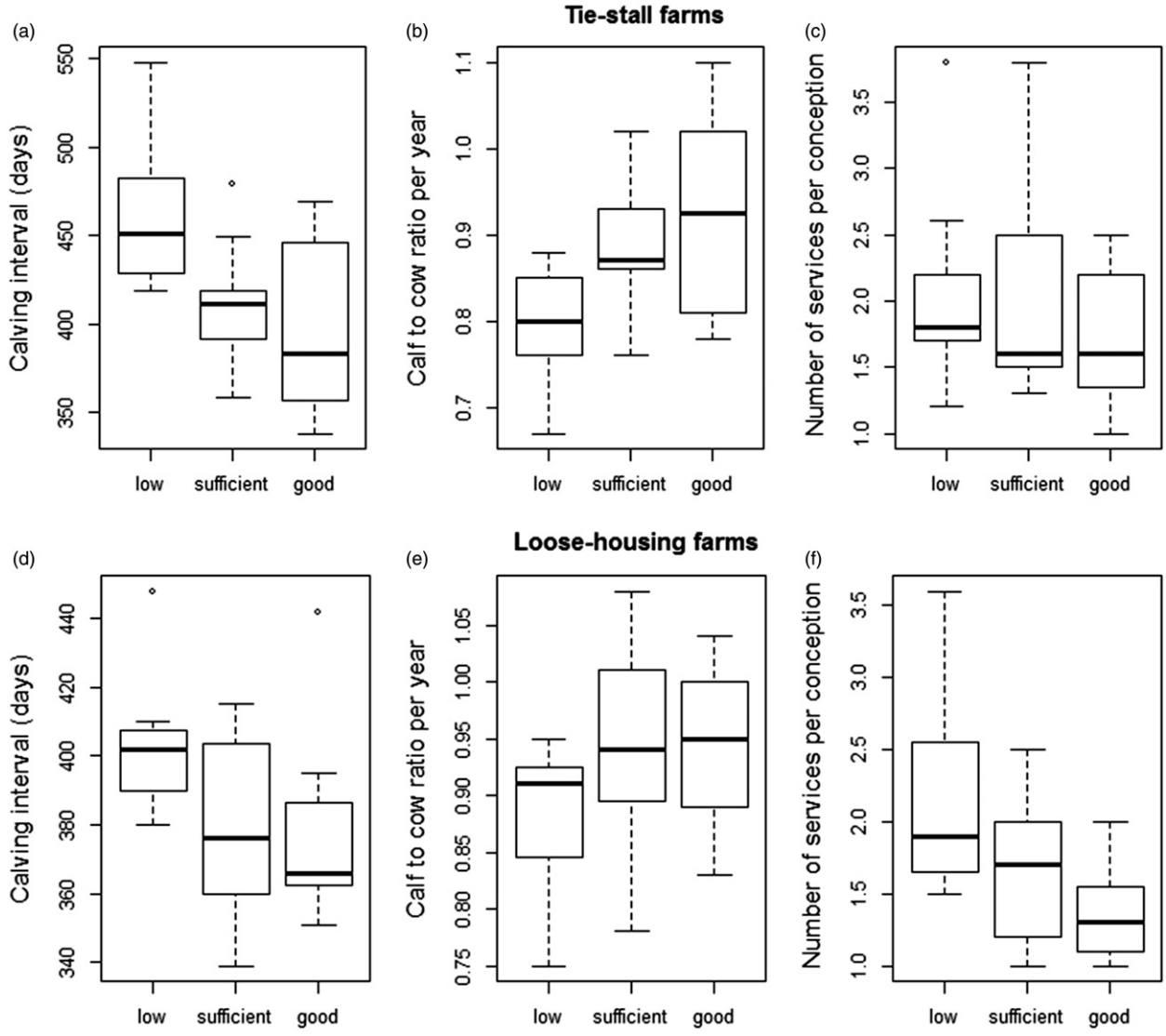


**Figure 1.** Boxplots of three reproductive parameters of Piemontese cattle (calving interval in days, calf to cow ratio per year, number of services per conception) according to welfare subgroups (low, sufficient and good farms) in tie-stalls (above: a, b, c) and loose-housing (below: d, e, f) systems.

compared to the tie-stall housing. In fact, the categories that most influenced the total score were related to the presence of pasture or outdoors areas, locomotion, social interactions and air conditions. As suggested by the Animal Health and Animal Welfare Panel on the welfare of dairy cows (EFSA 2009), the lack of space is the most important hazard for the development of leg and locomotion problems. In Piedmont, the loose-housing systems are not overcrowded, and a high number of loose housing farms had an outdoor area ($n = 15$) compared to tie-stall farms ($n = 5$).

The reproductive performances are a sensible stress indicator and a reliable index for animal well-being. A variety of stressors and stress pathways can directly or indirectly affect GnRH neurons and influence the reproductive axis and increased levels of 'stress' lead to an inability to reproduce (Von Borell et al. 2007).

In Table 2, the association between some reproductive parameters and welfare scores is reported. The mean calving interval was significantly shorter in loose-housing farms compared to tie-stalls ($p = .002$). This is in accordance with the study of Lof et al. (2007), and is probably due to the fact that oestrus can be more easily detected in loose systems, due to the possibility of expressing and observing specific behaviours (EFSA 2009; Simensen et al. 2010; Sawa and Bogucki 2011). We did not find differences in the mean calving interval among the welfare subgroups within the loose housing farms (for good, sufficient and low welfare farms: $379.6 \pm 30.9$, $378.4 \pm 27.0$ and $403.6 \pm 22.4$ days, respectively; Figure 1(d)).

Tied housing systems, however, give the possibility to handle and inspect single cows very easily. Indeed, if we examine the mean calving interval among tie-stall subgroups (Figure 1(a)), we observe a significantly prolonged interval ($p < .01$) in low welfare farms (460.3 ± 41.7 days) compared with sufficient (408.0 ± 32.9) and good (397.5 ± 50.5) farms, suggesting that a total good welfare score improves this parameter.

Accordingly, the annual calf to cow ratio was significantly higher in animals kept loose ($p = .016$). Within the tie-stall group, we observed a significant difference ($p = .018$) between the good (mean value: 0.88) and low welfare (mean value: 0.80) farms (Figure 1(b)) whereas no differences were detected among loose-housing subgroups mean values of 0.94 for good, 0.95 for sufficient and 0.88 for low welfare farms) (Figure 1(e)).

There was no evidence of statistically significant differences between housing systems in the number of services per conception ($p = .19$). Accordingly, no differences were observed among welfare level subgroups in tie-stall farms ($p = .49$; median values: 1.6 in good and sufficient farms, 1.8 in low welfare farms; Figure 1(c)). Although no significant differences ($p = .06$) were detected, we observed a trend in loose-housing farms indicating a lower number of services in good farms compared to low welfare levels group (median values: 1.3, 1.7 and 1.9 for good, sufficient and low welfare farms, respectively; Figure 1(f)).

No significant differences were detected between tie-stall and loose-housing farms as regards the pregnancy to cow ratio ($p = .19$). However, a statistically significant difference among welfare categories was recorded both in tie-stalls ($p = .01$, with a median rate of 3.3 in low welfare farms compared to 4.3 in sufficient farms) and in loose-housing ($p = .04$, median rate of 3.6 in low welfare farms compared to 4.9 in good farms).

As regards cattle culling, neither age nor percentage were statistically different between the two types of housing and among subgroups categories.

Our study showed that welfare in Piemontese cows, measured as ANI35/L2000 score, is significantly higher in farms with loose-housing than in those with tie stalls.

This result confirms the findings of other studies, that used a welfare score index (i.e. Welfare Quality® 2009) in dairy cows (Popescu et al. 2014).

The use of score indexes, as ANI35 by Bartussek and modified systems (as AWI system), proved to be an effective, rapid and economic tool applicable in the field (Amon et al. 2001; Popescu et al. 2014). Ofner et al. (2003) found significant correlations between the ANI 35 scores and behaviour and health, including results for skin lesions and injuries. Such assessment is deemed very important, since the housing and management can have a great impact on animal health and production and on the environment, and can thus influence the consumer's choice, so that it might become part of the export legislation in the future.

## Conclusions

The use of ANI35/L2000 score for the assessment of the farms and welfare conditions in this study enabled to obtain a reference score for animals kept in two different housing conditions. Loose housing system farms were characterised by higher welfare, thus confirming previous studies that used a score index on dairy cows. Further investigations are needed to have a more complete assessment of farm animal welfare. Score systems such as ANI 35/L2000 ANI are mostly based on resource based criteria, while the animal based criteria are quite deficient, but they enable to assess the quality of farming systems and can provide indicators for a fast inspection of herd during veterinary practice.

Finally, the impact of the housing system on reproductive parameters could stimulate breeders to abandon the tie-stalls system, improving the structures of the old and obsolete buildings.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## ORCID

Laura Tomassone http://orcid.org/0000-0003-2201-8802
Flaviana Gottardo http://orcid.org/0000-0002-0427-2180
Martina Tarantola http://orcid.org/0000-0001-7070-2700

## References

Amon T, Amon B, Ofner E, Boxberger J. 2001. Precision of assessment of animal welfare by the 'TGI 35 L' Austrian Needs Index. Acta Agric Scand A Anim Sci. 51:114–117.

Bartussek H. 1985. Vorschlag für eine Verordnung der Steiermärkischen Landesregierung für den Bereich der Intensivtierhaltung. Der Österr Freiberufstierarzt. 97:4–15.

Bartussek H. 2000. How to measure animal welfare? The idea of an "Animal Needs Index" ANI-35L [Tiergerechtheitsindex TGI 35L]: a practical tool for assessing farm animal housing conditions on farm level in respect to animals' well being and behavioural needs. Austrian experiences.

Proceedings of the II NAHWOA Workshop; Jan 8–11; Cordoba, Spain. p. 135–142.
EFSA. 2009. Scientific opinion of the panel on animal health and welfare on a request from the commission on the risk assessment of the impact of housing, nutrition and feeding, management and genetic selection on leg and locomotion problems in dairy cows. EFSA J. 1142:1–57.
Johnsen PF, Johannesson T, Sandoe P. 2001. Assessment of farm animal welfare at herd level: many goals, many methods. Acta Agric Scand. Suppl 30:26–33.
Lof E, Gustafsson H, Emanuelson U. 2007. Associations between herd characteristics and reproductive efficiency in dairy herds. J Dairy Sci. 90:4897–4907.
Mattiello S, Arduino D, Tosi MV, Carenzi C. 2005. Survey on housing, management and welfare on dairy cattle in tie stalls in western Italian Alps. Acta Agric Scand A Anim Sci. 55:31–39.
Mazurek M, Prendiville DJ, Crowe MA, Veissier I, Earley B. 2010. An on-farm investigation of beef suckler herds using an animal welfare index (AWI). BMC Vet Res. 6:55.
Ofner E, Amon T, Lins M, Amon B. 2003. Correlations between the results of animal welfare assessments by the TGI 35 L Austrian animal needs index and health and behavioural parameters of cattle. Anim Welf. 12:571–578.
Popescu S, Borda C, Diugan EA, Niculae M, Stefan R, Sandru CD. 2014. The effect of the housing system on the welfare quality of dairy cows. Ital J Anim Sci. 8:772–774.
Popescu S, Borda C, Diugan EA, Spinu M, Groza IS, Sandru CD. 2013. Dairy cows welfare quality in tie-stall housing system with or without access to exercise. Acta Vet Scand. 55:43.
R Core Team. 2015. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.r-project.org/.
Sawa A, Bogucki M. 2011. Effect of housing system and milk yield on cow fertility. Archiv Tierzucht. 3:249–256.
Simensen E, Østerås O, Bøe KE, Kielland C, Ruud LE, Naess G. 2010. Housing system and herd size interactions in Norwegian dairy herds; associations with performance and disease incidence. Acta Vet Scand. 52:14.
Starvaggi Cucuzza L, Riondato F, Macchi E, Bellino C, Franco G, Biolatti B, Cannizzo FT. 2014. Haematological and physiological responses of Piemontese beef cattle to different housing conditions. Res Vet Sci. 97:464–469.
Tarantola M, Valle E, De Marco M, Bergagna S, Dezzutto D, Gennero MS, Bergero D, Schiavone A, Prola L. 2016. Effects of abrupt housing changes on the welfare of Piedmontese cows. Ital J Anim Sci. 15:103–109.
Valde JP, Hird DW, Thurmond MC, Osteras O. 1997. Comparison of ketosis, clinical mastitis, somatic cell count, and reproductive performance between free stall and tie stall barns in Norwegian dairy herds with automatic feeding. Acta Vet Scand. 38:181–192.
Von Borell E, Dobson H, Prunier A. 2007. Stress, behaviour and reproductive performance in female cattle and pigs. Horm Behav. 52:130–138.
Welfare Quality®. 2009. Welfare Quality® Assessment Protocol for Cattle. Lelystad, The Netherlands: Welfare Quality® Consortium.