The effect of the housing system on the welfare quality of dairy cows

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Introduction

As defined by Broom, the welfare of an individual is its state as regards its attempts to cope with its environment (Broom, 1986). In this sense, welfare is a characteristic of the animal, not something that is given to it (Broom, 1991). If one were to compare the dairy industry to an open physical system, there are only a few major inputs (elements provided by the farmer to the dairy cows): housing, feeding (including watering) and human handling. The farm management chooses the elements of these, according to the possibilities of the farmer and the perceived needs of the animals. The outcomes are all the characteristics of the cows that are influenced by the inputs: the productive and reproductive performance, the physical health and mental wellbeing; essentially the production and welfare of the cows. It has been shown that the interactions between production system and management can lead to large variations in herds with regard to animal welfare (Sandoe et al., 1997) so that the housing type constitutes an important element of influence. Thus, it becomes clear that the different aspects, elements, facilities and equipments of the housing environment may influence the ability of the animal to cope with it. For example, the number, design and placement of the feeding and drinking facilities may influence the activities of the cattle (food and water intake) but also their social behaviour and the occurrence of physical injuries (Rousing et al., 2000). Many different variations of cattle housing exist, but most of these can be included in two major categories, according to the confinement degree of the cows: the loose or the tie-stall housing system. The advantages and disadvantages of both of these and their effects on the health and behaviour of the dairy cows have been extensively studied. Thus, compared to the more traditional tie-stall systems, loose housing comes with the advantage of better udder health (Hultgren, 2002; Regula et al., 2004), lower risk of ketosis and better fertility (Valde et al., 1997), generally being accepted by welfare scientists as having a superior potential for higher animal welfare (Rousing et al., 2000). Loose housing systems, nevertheless, have the disadvantage of a higher risk of lameness (Cook, 2003; Sogstad et al., 2005). There is some evidence that loose-housing (Weary and Taszkun, 2000) and regular outdoor exercise (Gustafson, 1993; Regula et al., 2004) have positive effects on the health and welfare of dairy cows. Yet, fewer studies were conducted on the overall welfare of the dairy cows in different housing conditions.

The aim of this study was to assess the effect of the housing system (loose vs tied-stall) on the dairy cows’ welfare and to test the hypothesis that dairy cows in loose housing system have a better welfare quality than those kept in tie-stalls.

Materials and methods

The farms

The study was conducted in 60 selected commercial dairy farms (mean ± sd, 84±36.2 lactating cows), 30 with tie stalls (mean ± sd, 70±30.5 lactating cows) and 30 with loose housing system (mean ± sd, 98±36.7 lactating cows), from Transylvania, Romania. The selection criteria were: management practices, farm size, veterinary records and agreement of the farmers to take part in the study.

In both the loose and tied housing systems, the cattle breeds were Holstein (30%) and Romanian Spotted Cattle (70%). The mean milk production per cow per year in the farms with loose housing systems (LHS) was 5089.2 kg, and in those with tie-stall housing systems (THS) 5197.0 kg. All the tie-stall farms were closed, with solid flooring. The cows were kept on stalls with length between 160 cm and 250 cm, and width between 85 cm and 190 cm. In 90% of the tie-stall farms bedding was used (straw or sawdust) in small quantity (1.3 kg/head/day or less). The cows had access to exercise (pasture or paddock) in 13 tie-stall...
farms. The cows were pasturing on average 10.6 hours a day for 182 days a year. The milking was done manually (six farms) or mechanically (24 farms), in the barns. The farms with loose system (LHS) were both closed and half-opened, having cubicles (22 farms) or straw yards (eight farms) for the cows’ rest. In the majority of the free-stall barns, sawdust bedding was used. The milking (automatic) was done in milking parlours, twice per day. In the warm season, the cows were pasturing in five of the farms (on average 8 hours a day, 192 days a year). Each farm was visited once in the winter months, when the cows were housed.

Welfare assessment

The basis and reference material for the welfare assessment of the cows in this study was the Welfare Quality® Assessment Protocol for Cattle (Welfare Quality Consortium, 2009). Two trained assessors evaluated the cows in each farm. The assessors, experienced in cows’ welfare evaluation, have used the assessment protocol before this study, in four farms with different housing systems (LHS and THS), having smaller numbers of animals (50 cows on average, data not included in this study). The training was finalised when an inter- and intra-observer agreement of at least 80% was reached for each measure of the protocol. A total number of 2624 milking cows (1205 cows in farms with THS and 1419 cows in farms with LHS) were evaluated; their number in each farm was established according to the instructions of the Welfare Quality assessment protocol. This protocol includes four major welfare principles, 12 criteria and 29 measures (Table 1). The validity, feasibility and repeatability of the welfare measures recorded were established in previous studies (Knierim and Winckler, 2009).

To avoid disturbing the farming activities and to conduct the assessment without interruption, prior arrangements were made with each animal unit’s manager, regarding the date, hour and estimated duration of the farm visits. Also, the farm visits were planned so that at least four weeks passed from the last hoof trimming session (for a relevant lameness evaluation). The general investigation of the farms took place during the morning milking of the cows. Taking into account the total number of the milked cows in the farm, as recommended by the assessment protocol, a random selection of animals took place (every nth cow in the milking parlour in the LHS farms or every nth cow in a row in the THS farms). The selected animals were marked with an animal marker, and then the same cows were assessed for the scoring of all measures, where random sampling was required. Most of the clinical scoring (body condition score, body cleanliness, integument alterations, nasal, ocular and vulvar discharge, diarrhoea) took place immediately, and consecutively the cows were marked. To detect lameness the cows were observed when exiting the milking parlour in the LHS farms or were evaluated tethered in the THS farms. The avoidance distance test was performed then at the feeding bunk. The next measure assessed was the Qualitative Behaviour Assessment (QBA) and the other behavioural observations (time needed to lie down, animals colliding with housing equipment during lying down, animals lying partly or completely outside the lying area, agonistic behaviours and also coughing was observed here). For the assessment of agonistic behaviours continuous behavioural sampling was applied (in one to three segments of the barn, depending on the number of the cows in the barn). The resources of the farm were examined (measures regarding the water-sources) and at the end of the on-farm welfare assessment the unit’s manager was interviewed. In this questionnaire the farmer’s answers were recorded regarding the exercise allowance for the cows (access to outdoor loafing area or pasture), on-farm procedures (disbudding/dehorning, tail docking) and health-record data (milk somatic cell count, mortality, dystocia, and downer cows). Detailed information about the methodology of assessment can be found in the Welfare Quality® Assessment Protocol for Cattle (Welfare Quality Consortium, 2009).

Data collected in the farms were processed using the Welfare Quality® scoring system software program for the calculation of the scores for the welfare criteria and principles and for classifying the farms in a welfare category (not classified, acceptable, enhanced and excellent) on three levels: criteria, principles and final. Data were expressed as the number of animals affected out of the total number of animals assessed in each unit (farm).

Table 1. Principles, criteria and parameters of the Welfare Quality® assessment protocol for dairy cows (Welfare Quality Consortium, 2009).

| Welfare principles | Welfare criteria | Measures |
|--------------------|------------------|----------|
| Good feeding       | Absence of prolonged hunger | Body condition score |
|                    | Absence of prolonged thirst | Water provision; cleanliness of water points; water flow; functioning of water points |
| Good housing       | Comfort around resting | Time needed to lay down; animals colliding with housing equipment during lying down; animals lying partly or completely outside the lying area; cleanliness of udders, flank/upper legs, lower legs |
|                    | Thermal comfort   | As yet, no measure is developed. |
|                    | Ease of movement  | Presence of tethering; access to outdoor loafing area or pasture |
| Good health        | Absence of injuries | Lameness; integument alterations |
|                    | Absence of disease | Coughing; nasal discharge; ocular discharge; hampered respiration; diarrhoea; vulvar discharge; milk somatic cell count; mortality; dystocia; downer cows |
|                    | Absence of induced pain | Disbudding/dehorning; tail docking |
| Appropriate behaviour | Expression of social behaviours | Agonistic behaviours – assessed by observation of head butts; displacements; chasing; fighting; chasing-up |
|                     | Expression of other behaviours | Access to pasture |
|                     | Human-animal relationship | Avoidance distance |
|                     | Positive emotional state | Qualitative behaviour assessment – by observation of the cows’ body language regarding 20 behavioural terms (active, relaxed, fearful, agitated, calm, content, indifferent, frustrated, friendly, bored, playful, positively occupied, lively, inquisitive, irritable, uneasy, sociable, apathetic, happy, distressed) |
Statistical analysis

All statistical analyses were performed using SPSS for Windows version 17 (SPSS Inc., Chicago, IL, USA). Descriptive statistical indicators were determined (mean, standard error of the mean, median, range) for the 29 assessed measures, for the scores of the 11 criteria: absence of prolonged hunger (APH), absence of prolonged thirst (APt), comfort around resting (CAR), ease of movement (EM), absence of injuries (AI), absence of diseases (AD), absence of pain induced by management procedures (APMP), expression of social behaviours (ESB), expression of other behaviours (EOB), good human-animal relationship (GHAR), positive emotional state (PES) and for the scores of the four welfare principles (good feeding, good housing, good health, appropriate behaviour) in the farms with LHS and THS. The statistical significance of the housing system’s effect on welfare (measures, criteria and principles of welfare) in the studied farms was determined by the t-test or the Mann-Whitney test, depending on the normal or abnormal distribution of the data, established with the Kolmogorov-Smirnov test. P values less than 0.05 were considered as significant.

Results and discussion

Animal based measures of good feeding, housing and health

Table 2 comparatively presents the descriptive statistical indicators (mean, standard error of the mean, median and range) of the animal-based measures for the principles of good feeding, housing, and health, assessed in the barns and tie-stall farms. Significant differences were found between the two housing systems, for 14 out of 21 parameters. The analysis of the results shows some advantages of the loose housing for the dairy cows.

No significant difference (P>0.05) between LHS and THS was found in the mean percentage of very thin cows, although it was slightly higher in the farms with LHS. In both systems the percentage of very thin cows was higher than that obtained by Regula et al. (2004) in loose and tie-stall farms in Switzerland and by Ostojic-Andric et al. (2011) in Serbia. Besides the fact that the cows loose weight because of the inadequate quality and quantity of the feed, in LHS often the feed-front is too short for the simultaneous feeding of all of the animals (Estevez et al., 2007). Also, the lame cows spend less time in feeding (Gomez and Cook, 2010). The high percentage of the lame cows in LHS may be one of the causes of the high number of thin cows.

The tied cows needed significantly longer average time to lay down than those in free housing (P<0.001), but less than 6,30 seconds, which indicate moderate problems from the point of view of welfare (Welfare Quality Consortium, 2009). This result is in line with those obtained by other researchers (Krohn and Munksgaard, 1993; Plesch, 2011). In tie-stall cows may have problems to lie down due to the bad design of the tethers, the manger edge being too high, short stalls or a neck bow being in the way (Hoffmann and Rist, 1975). Moreover, the painful conditions of the legs, vertebral column and udder can lead to increased lying down times (Fregonesi and Leaver, 2002). The desire of the cows to lie down is influenced also by the hygiene of the resting surfaces in the barns and of the bedding, the cows preferring the clean, dry and soft surfaces for resting (Rushen et al., 2007).

Frequency of collisions with housing equipment while lying down represents a serious welfare problem only in the tie-stall farms assessed in our study (Table 2). The animals colliding with housing equipment while lying down are recorded by the Welfare Quality® protocol during the behavioural observations. Imbalance of the animal while lying down and

Table 2. Descriptive statistics for animal based measures related to the principles of good feeding, housing and health in LHS (n=30) vs THS (n=30) and significance of differences between the two housing systems.

| Measure                              | LHS Mean ±SEM | Median | Range   | THS Mean ±SEM | Median | Range   | P    |
|--------------------------------------|---------------|--------|---------|---------------|--------|---------|------|
| Very lean cows, %                    | 13.12±3.68    | 3.54   | 60.97   | 10.22±1.96    | 8.16   | 37.14   | 0.533|
| Duration of lying down movements, s  | 5.12±0.10     | 5.15   | 1.95    | 6.07±0.19     | 5.99   | 5.01    | <0.001|
| Lying down movements with collisions, % | 1.15±0.38     | 0.00   | 6.78    | 30.99±4.75    | 30.61  | 83.67   | <0.001|
| Cows which lie partly outside lying area, % | 0.48±0.19     | 0.00   | 3.39    | 3.19±1.13     | 0.00   | 26.92   | 0.162|
| Cows with dirty lower legs, %       | 50.72±4.27    | 51.79  | 46.16   | 33.47±2.75    | 30.61  | 85.72   | <0.001|
| Cows with dirty udder, %            | 25.23±1.44    | 24.39  | 32.05   | 43.31±1.89    | 42.85  | 55.71   | <0.001|
| Cows with dirty flank and upper legs, % | 32.69±1.27    | 27.78  | 68.29   | 20.67±1.21    | 21.725 | 21.45   | 0.243|
| Cows with at least one hairless patch, % | 12.71±1.44   | 12.76  | 35.32   | 47.74±2.34    | 48.92  | 63.46   | <0.001|
| Cows with at least one lesion, %     | 20.70±3.42    | 15.38  | 67.80   | 18.71±1.80    | 20.18  | 36.73   | 0.610|
| Frequency of coughing, per cow per 15 min | 0.00         | 0.00   | 0.00    | 0.21±0.20     | 0.00   | 6.25    | 0.317|
| Cows with nasal discharge, %        | 0.11±0.10     | 0.00   | 3.22    | 1.09±0.38     | 0.00   | 6.25    | 0.019|
| Cows with ocular discharge, %       | 0.00          | 0.00   | 0.00    | 0.38±0.29     | 0.00   | 8.16    | 0.154|
| Cows with increased respiratory rate, % | 0.00         | 0.00   | 0.00    | 1.17±0.57     | 0.00   | 11.54   | 0.040|
| Diarrhoea, %                        | 0.47±0.29     | 0.00   | 7.31    | 2.98±1.04     | 0.00   | 23.07   | 0.023|
| Vulvar discharge, %                 | 0.98±0.38     | 0.00   | 7.41    | 1.36±0.54     | 0.00   | 14.00   | 0.675|
| Mastitis, %                         | 8.57±0.94     | 8.00   | 18.00   | 11.58±1.02    | 12.00  | 19.00   | 0.034|
| Mortality, %                        | 1.35±0.21     | 1.00   | 4.00    | 2.26±0.28     | 2.00   | 5.50    | 0.011|
| Dysocicia, %                        | 1.59±0.22     | 1.00   | 4.00    | 2.47±0.34     | 2.00   | 6.00    | 0.034|
| Downer cows, %                      | 1.08±0.10     | 1.00   | 2.00    | 0.43±0.13     | 0.00   | 2.00    | <0.001|
| Dehorned cows, %                    | 67.57±5.57    | 77.00  | 100.00  | 80.65±5.61    | 100.00 | 100.00  | 0.021|

LHS, loose housing system; THS, tie-stall housing system; * in LHS the measure lane cows include the percentage of the moderately and severely lame cows.

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consequent hitting of the physical elements of the barn can occur also when the animal protects a painful leg and avoids bearing weight on it (Cook and Nordlund, 2009). Collisions with housing equipment indicate disturbances of resting comfort for dairy cows (Hörning, 2003). Even if the percentage of the cows that lie partly outside of the lying area was not significantly influenced by the housing system, moderate problems were observed only in THS (Welfare Quality Consortium, 2009), because of the improper dimension of the stalls. Plesch (2011) found similar results in German tie-stalls.

The number of cows with dirty lower legs was significantly higher (P<0.001) in the loose housing system than in the tied housing, while the flank region of the tethered cows was dirtier (Table 2). This aspect was signalled also by other researchers in their studies (Cook, 2002; Zurbrigge et al., 2005). Even if the percentage of the cows with dirty udders was significantly higher in TSH, the situation is alarming in both systems (Welfare Quality Consortium, 2009). For dairy cows, the consequence of poor hygiene is a high risk of mastitis and worsening of lameness (Cook, 2002; Reneau et al., 2005). The dirtiness of the three body regions demonstrated in this study is mainly caused by disregarding of the recommendations for daily cleaning and bedding change in the barns, but also by the improper stall length. For dairy cows, lameness represents a severe welfare problem decreasing mobility and impairing normal behaviour (Whay et al., 2003). The lameness prevalence in our study was higher in loose housing than in the tie-stalls, but the difference was not statistically significant (P>0.05). Several studies have reported lower rates of lameness in tie-stall herds, compared to free stall herds (Cook, 2003; Sogstad et al., 2005). This suggests that free stalls expose cattle to adverse environmental conditions, which are important to the epidemiology of lameness (Cook and Nordlund, 2009). The prevalence of lameness varies in the studies made in different countries of the world, ranging from 20% (Espejo et al., 2006) to 48% (Dippel et al., 2009) for loose housing systems and from 1% to 21% in tied systems (Cook, 2003; Sogstad et al., 2005, Zurbrigge et al., 2005). In Romania data are available only for the lameness prevalence in tie-stall housing and it is similar with that obtained in this study (Popescu et al., 2010b).

The increase in lameness prevalence is associated with solid concrete flooring, slippery walking alleys (Cook and Nordlund, 2009), uncomfortable and dirty barns (Cook, 2002, 2003; Espejo et al., 2006; Chapinal et al., 2013), increased degree of dirtiness in cows' hind legs (Cook, 2002; Zurbrigge et al., 2005) and zero-grazing (Haskell et al., 2006). Because in our study the mean prevalence of lameness exceeds 15%, we can state, referring to Nordlund et al. (2004) that the implementation of specific measures is urgently needed to decrease lameness in 67% of the evaluated farms.

The proportion of cows with at least one hairless patch and no lesion was significantly lower (P<0.001) in the loose system, which is in line with results of other studies (Busato et al., 2000; Regula et al., 2004; Simensen et al., 2010). The most affected areas were the hock and neck; which was caused by the short resting beds (<160 cm length), the absence or the reduced quantity of bedding (1.5 kg/head/day or less) and the short chains (mean ± sd, 69.6±17.53 cm) used for the cows' tethering. Body lesions were observed especially at the animals' hock, without significant differences (P>0.05) between the two housing systems. However, in both systems the prevalence of body lesions was lower than it was found in other studies (Weary and Taszkun, 2000; Zurbrigge et al., 2005).

The percentage of cows with ocular discharge, increased respiratory rate, diarrhoea, mastitis and dystocia was significantly lower in LHS than in THS (P<0.05). Health problems have been associated with use of tie stalls in many studies (Gustafsson, 1993; Hultgren, 2002; Ostojic-Andric et al., 2011; Regula et al., 2004). Mastitis is a multifactorial disease, that is considered to be one of the most frequent and costly diseases in the dairy industry (Kossaibati and Esslemont, 1997). Besides the economic effects, mastitis impairs milk quality. As in our study the mastitis prevalence exceeds 4.5% (Welfare Quality Consortium, 2009) in both LHS and THS, an action plan at farm level would be necessary to remediate this problem. The higher dystocia rate in THS than in LHS is probably caused by the lack of exercise (Gustafsson, 1993; Mee, 2004). Mortality was significantly higher in THS than in LHS (P<0.05), similar to that recorded by Ostojic-Andric et al. (2011) in a recent study in Serbia. Thomsen et al. (2006) found that tie stalls tended to have higher mortality rates than free stalls with cubicles, although the difference was not statistically significant. However, other researchers found higher mortality rates in loose than in tie-stall housing (McConnel et al., 2008; Decho et al., 2011; Alvåsen et al., 2012). Even if the percentage of downer cows was significantly higher in LHS than in THS (P<0.001), it does not represent an important welfare problem due to the low values recorded in both systems (Welfare Quality Consortium, 2009). The most common cause of downer cow syndrome is hypocalcaemia, but it is also caused by injuries, muscle and nerve damage, macro-mineral deficiencies, toxic mastitis or metritis (Greenough, 2005).

**Behavioural measures**

The results obtained by the assessment of the behavioural parameters in the two housing systems are shown in Table 3. Significant differences can be observed between LHS and

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**Table 3. Descriptive statistics for the behavioural measures in LSH (n=30) vs THS (n=30) and significance of differences between the two housing systems.**

| Measure                              | LHS Mean ±SEM  | Range | THS Mean ±SEM | Range | P       |
|--------------------------------------|----------------|-------|--------------|-------|---------|
| Frequency of butts, per cow per hour | 0.55±0.14      | 2.91  | 0.43±0.05    | 0.87  | 0.010   |
| Frequency of displacements, per cow per hour | 0.69±0.13      | 2.63  | 0.08±0.01    | 0.07  | 0.016   | <0.001 |
| Cows that can be touched, %          | 35.59±2.13     | 0.9   | 75.15±3.91   | 83.75 | <0.001  |
| Cows that can be approached by 50 cm but not touched, % | 26.63±2.48     | 54.91 | 33.37±3.66   | 28.33 | 0.134   |
| Cows that can be approached between 50 cm and 1 m, % | 31.77±2.99     | 63.43 | 6.30±1.55    | 3.06  | 0.05    |
| Cows that cannot be approached, %    | 7.63±1.25      | 30.64 | 3.11±0.96    | 0.00  | 25.00   | 0.0002 |
| QBA                                  | 1.68±0.30      | 5.73  | -5.01±0.24   | 5.17  | 5.55    | <0.001 |

LHS, loose housing system; THS, tie-stall housing system; QBA, qualitative behaviour assessment.
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THS for the majority of the behavioural indicators. With the exception of QBA, these are better for tie-stall housing. In loose housing head butts occurred twice more often than in the tie-stalls, which is in agreement with the findings of Laister et al. (2009). Also, the occurrence of displacements was more frequent than that of head butts in loose housing. The advantage of THS is obvious if we are considering the percentage of the cows that can be touched or those that can be approached at different distances. This aspect has also been signalled in other studies (Mattiello et al., 2009; Popescu et al., 2010a) and probably represents one of the advantages of tethered cattle rearing. The Qualitative Behaviour Assessment (QBA) was calculated based on the behaviours and body language of the cows, following certain descriptors specified in the Welfare Quality® protocol (Table 1). QBA was significantly higher in LHS than in THS (P<0.001). Permanent tethering may have a negative effect on the behaviour of the cows throughout their constant stay in the barns, such as lack of comfortable resting surfaces, absence of movement possibility and lack of social interactions.

Welfare criterion and principle scores

The descriptive statistics of the scores for the 11 criteria and four principles of welfare in the two housing systems (LHS and THS) are presented in Table 4. Except for the criteria ESB, EOB and GHAR, the mean scores are higher in farms with LHS than in those with THS. The principle of good feeding includes two criteria (APH and APT) and a series of measures which are more resource-based (Table 1). The scores obtained for this principle are significantly higher in loose housing than in tie-stall farms (P<0.05), due to the more adequate water provision in the former. For the criterion APT no significant differences were recorded (P=0.05). The scores for the APT criterion were significantly higher in farms with LHS than in those with THS (P<0.001). The primary reason for this situation was the insufficiency of the properly working watering devices and the restrictive watering in many farms with THS (twice a day). In this system the majority of the participating farms had one water bowl per two cows. According to Andersson et al. (1984) one water bowl per cow is recommended because the submissive cow drinks less and gives less milk than the dominant animal in every cow pair. Restricting the water intake of cows by 50% will result in 74% lower milk yield and more aggressive behaviour (Little et al., 1990). In addition, in 57% of the studied farms with THS the water flow rates were too low. Cows have a natural drinking rate of about 15 l per minute and they drink more if the water flow rate is high (Andersson et al., 1984). The Welfare Quality® Consortium emphasises a well known truth, demonstrated by many studies (Little et al., 1980; Meyer et al., 2004), yet still undervalued by farmers: the importance of unlimited access of the animals to drinking water in adequate quantity. Despite the attention paid to other nutrients, the quantity and quality of water are not sufficiently considered (Beede, 2005). Prolonged thirst has more negative repercussions on the animals’ welfare than prolonged hunger, especially in the case of milking cows, whose organism uses high quantities of water in order to produce milk.

Cardot et al. (2008) showed that lactating cows drink in average more than three times their mean daily milk yield and other studies showed that each kilogram of milk produced requires from 1.24 (Dahlbom et al., 1998) to 1.30 (Meyer et al., 2004) litres of drinking water. Precisely because of the higher importance of good watering compared to that of good feeding, all the farms with low scores for the criterion APT had low scores for the good feeding principle as well.

The scores for the principle of good housing, and also for the included criteria (CAR and EM) were significantly higher in the farms with loose housing (Table 4). Those farms with LHS which do not allow the access of the cows in paddocks had lower scores (26 farms) and those which provide this access were awarded with higher scores (4 farms). Within the farms with THS, nine had low scores, because these do not allow the access of the cows to exercise, not even in paddocks. Phillips (2002) states that today’s cattle need exercise to keep healthy and productive. In permanently tethered cows the normal behavioural patterns become modified, the frequency of all social and investigative behaviours lowers and abnormal behaviours may occur (Krohn, 1994). In this study all the loose housing farms had high scores for the criterion EM, while more than 50% of the tie-stall farms had low

Table 4. Descriptive statistics for welfare principle and criteria scores in farms with LHS (n=30) vs THS (n=30) and significance of differences between the two housing systems.

| Principles and criteria | LHS Mean±SEM | LHS Median | Range | THS Mean±SEM | THS Median | Range | P       |
|-------------------------|--------------|------------|-------|--------------|------------|-------|---------|
| 1st principle Good feeding | 55.36±3.69   | 61.75      | 91.80 | 37.50±4.48   | 45.05      | 59.70 | 0.014   |
| Criterion: APT          | 66.12±6.52   | 74.55      | 92.00 | 60.77±5.52   | 52.50      | 82.30 | 0.605   |
| Criterion: EM           | 67.43±3.83   | 60.00      | 97.00 | 39.10±5.10   | 60.00      | 57.00 | <0.001  |
| 2nd principle Good housing | 70.71±1.19   | 70.90      | 31.50 | 26.51±1.72   | 23.90      | 24.40 | <0.001  |
| Criterion: CAR          | 53.54±1.88   | 53.80      | 38.80 | 33.18±2.54   | 30.30      | 33.00 | <0.001  |
| Criterion: EM           | 100.0±0.00   | 100.00     | 0.00  | 23.23±1.74   | 15.00      | 19.00 | <0.001  |
| 3rd principle Good health | 48.81±2.11   | 44.75      | 59.40 | 41.32±2.96   | 35.05      | 38.10 | 0.334   |
| Criterion: APT          | 58.27±4.31   | 58.85      | 54.50 | 52.37±2.52   | 49.50      | 71.20 | 0.440   |
| Criterion: AD           | 86.57±3.50   | 100.00     | 59.50 | 71.11±4.21   | 74.40      | 72.70 | 0.003   |
| Criterion: APIMP        | 33.40±5.29   | 22.00      | 87.00 | 30.10±4.91   | 13.00      | 37.00 | 0.217   |
| 4th principle Appropriate behaviour | 38.16±3.21   | 30.10      | 43.10 | 7.78±2.59    | 19.40      | 58.10 | 0.030   |
| Criterion: ESB          | 91.56±2.43   | 98.80      | 3.40  | 99.88±0.11   | 100.00     | 41.90 | <0.001  |
| Criterion: EOB          | 14.80±5.51   | 0.00       | 77.20 | 31.51±6.71   | 0.00       | 80.00 | 0.076   |
| Criterion: GHAR         | 46.88±2.43   | 44.60      | 69.00 | 72.0±2.73    | 73.20      | 53.30 | <0.001  |
| Criterion: PES          | 67.38±2.81   | 71.00      | 33.10 | 14.57±1.43   | 13.05      | 51.60 | <0.001  |

LHS, loose housing system; THS, tie-stall housing system; APH, absence of prolonged hunger; APT, absence of prolonged thirst; CAR, comfort around resting; EM, ease of movement; AI, absence of injuries; AD, absence of diseases; APIM, absence of pain induced by management procedures; ESB, expression of social behaviours; EOB, expression of other behaviours; GHAR, good human-animal relationship; PES, positive emotional state.
scores. Within the criteria of the good health principle, only AD was significantly influenced by the housing system (Table 4). For the assessment of the APIMP criterion, the disbudding/dehorning and tail docking procedures are considered. Tail docking of dairy cows is not practiced in Romania, thereby avoiding this harmful effect for the welfare of the cows. Therefore, the score for this criterion was based only on the dehorning practices of the cows. In the majority of the medium and large farms, the farmers prefer the cows not to have horns. In the assessed farms, disbudding of the calves is not performed at all, probably because the farmers do not want to replace the herd by own production and thus do not want supplementary costs with the calves which will be sold. Therefore, the basic procedure in the evaluated farms is the dehorning of mature cows. Certainly, the process of dehorning is a source of stress and pain for the animal, particularly if performed without anaesthesia or analgesia (Hewson et al., 2007). Within this criterion, maximal scores were obtained by those farms where the cows are not dehorned. In the majority of the investigated farms, both with loose system and also with tie-stalls, where dehorning is performed, low scores were obtained for this criterion, because of the lack of analgesia and anaesthesia. The cows’ dehorning is not performed by the farmers in any of the investigated farms, but the farmers ask the veterinarians to perform at most local anaesthesia, to keep the costs as low as possible. The mean score for the appropriate behaviour welfare principle was significantly higher in the loose system even if within the component criteria only the score for PES was in favour of this system (Table 4). The evaluation of the ESB criterion is based on the observation of agonistic behaviours in the cows. High mean scores were obtained by all the tie-stall farms for this criterion. In the farms allowing the cows’ access in paddocks a minimum level of social interaction was observed in the animals. However, the short time period in which the cows were untied did not allow the detailed observation of their behaviours. In the farms with LHS the agonistic interactions in stable dairy cattle groups indicated the presence of some problems. The most frequent agonistic interactions occurred at the feeding or watering front, indicating insufficiency of food and/or water. This aspect was observed also in other studies (Menke et al., 2000). The EOB criterion is based on assessing the cows’ access to pasture. For this criterion, high scores were awarded, in both housing systems, only to the farms where the cows have access to pasture (6 farms with LHS and 13 with THS). The access of dairy cows to pasture and generally to outside exercise prevents and reduces the incidence of lameness (Haskell et al., 2006), increases the resistance of their immune system, stimulates the reproductive function and improves the behavioural parameters in the sense of displaying natural behaviours (Krohn, 1994). The obviously positive mental state expressed through body language observed frequently in healthy cows on a qualitatively and quantitatively sufficient pasture can rarely be seen in stabled conditions, regardless of how adequate the housing conditions and the equipments are (Phillips, 1993). Generally speaking, pasturing enhances the welfare level of the cows (Boyle et al., 2008). Very low scores were recorded in the farms where the cows did not have access to pasture. The permanent housing (zero-grazing system) is not adequate because of its possible negative impact on the health (Haskell et al., 2006; Kaufmann et al., 2012), welfare, and production of dairy cows (Burow et al., 2011).

Unfortunately in the past years the zero-grazing system has been spreading in Romania, because of the concerns of the farmers for their animals and often due to commodity or the lack of pastures, especially in the large farms. The mean score was significantly higher in the farms with THS than in those with LHS for the GHAR criterion. This criterion was assessed based on the avoidance distance at the observer’s approach. Recent researches showed in Romania a better stockmanship in the THS compared with that in LHS, due to the more frequent animal-human contact during tethering/untethering, feeding, watering, milking and cleaning the barns (Popescu et al., 2009). The scientific studies have proved that when the dairy cows show fear towards humans and towards the stockman, their productivity, behaviour and welfare are impaired (Bertenshaw and Rowlinson, 2009; Wahlinger et al., 2006). Significantly lower scores were obtained in THS for the PES criterion (Table 4), probably due to the restrictions inherent to tie-stall housing.

The final assessment

Based on the scores obtained for the four welfare principles, each farm was classified in a welfare category. The farms with LHS were in the enhanced (21 farms) and “acceptable” (9 farms) categories, while those with THS were categorised as enhanced (5 farms), acceptable (19 farms) and not classified (6 farms) (Figure 1). No farm had an excellent level, similar to the results obtained in other countries (De Vries et al., 2011; Keeling, 2009; Ostojic-Andric et al., 2011). Studies about cattle welfare assessment using the WQ protocol in different housing systems are not widely published, making it difficult to compare the final results. The final classification of the farms with LHS and THS in different welfare categories is in line with the results obtained recently by Ostojic-Andric et al. (2011) in Serbia.

Conclusions

This study demonstrated that the welfare of dairy cows is significantly influenced by the housing system, and that the loose system has advantages when it comes to the feeding, housing and behaviour of the dairy cow. In conclusion, the results obtained allow us to confirm the hypothesis of the research, namely that dairy cows in the loose-housing system have a better welfare quality than those kept in tie-stalls. One of the great achievements of the
Welfare Quality® system is the fact that it does allow the compensation only to a certain extent of the lower scores for one aspect with the higher scores obtained for another aspect of the protocol. This way the shortcomings in the cows’ welfare in each assessed farm become obvious. The situation revealed by this study is concerning, because there is a low probability that certain management factors, which have lead to low scores, will be changed in the near future. Such factors include the housing system itself and the decision of permanent housing, the failure to provide the access of the cows to daily exercise in paddocks, the inadequate provision of drinking water for the animals and the lack of disbudding of calves as an alternative to the dehorning of adult animals.

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