Welfare Assessment in Tunisian Dairy Herds by Animal-Linked Parameters and Performance Efficiency

Research Article

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ABSTRACT

Animal welfare considerations are becoming increasingly important for farming of animals, both in Tunisia and internationally. Practices which may have once been deemed acceptable are now being reassessed in the light of new knowledge and changing attitudes. And a clearly defined concept of welfare is needed for use in precise scientific measurements. If animal welfare is to be compared in different situations or evaluated in a specific situation, it must be assessed in an objective way. Likewise, welfare is a multidimensional concept and its assessment systems have been developed by researchers of the European project Welfare Quality®. These systems should include animal-based measures directly related to animal body condition, health aspects, injuries and behavior. In this context, a Tunisian study was carried out in 35 dairy farms to evaluate welfare quality of Tunisian Holstein population cows through some welfare indicators validated by the European project Welfare Quality®. The studied sample included 350 females (Holstein; 161 heifers and 189 cows). Avoidance distance (at the feeding rack and inside the stable), body condition, lameness, fertility, somatic cell count, and milk yield were assessed. The study showed that animals differ in their relationship with the stockholder, performance, and health state, early experience and temperament.

KEY WORDS avoidance distance, behavior, human-animal relationship, lameness, welfare.

INTRODUCTION

There are many confusing nuances within the concepts of animal welfare, animal well-being, animal rights, and related terms. During the years in which humans and animals have interacted since animal domestication, changes have been made in both the animals and their husbandry. Many attempts have been made to define the term welfare as applied to animals. Two recent and widely used definitions are: "Welfare on a general level is a state of complete mental and physical health where the animal is in harmony with its environment" (Hughes, 1976), and "The welfare of an individual is its state as regards its attempts to cope with its environment" (Broom, 1986). Both definitions refer in a general way to the balance which exists between the animal and its surroundings. They are not immediately helpful at the practical level in determining whether an animal is in fact enjoying a correct balance.

In Tunisia, this term is new for the farmers who treat with care her animals and ensure that their herd's requirements are accommodated. This paper is a description of the state of dairy cattle welfare under Tunisian conditions. It will be helpful for farmers to have an idea regarding animal welfare and its significance to improve their income and to

achieve the sustainability of the dairy sector.

In this context, welfare assessment has many roles such as identifying current welfare problems, checking farm assurance, indicating risk factors leading to a welfare problem, testing the efficacy of interventions, researching tool for evaluating and comparing production systems, environments, management systems, animal genotype etc. (Whay, 2007). Hristov *et al.* (2008) reported that there is major public demand for improvements in animal welfare, housing conditions and health aspects.

A scientific assessment of animal welfare was compiled earlier by Fox (1984), who studied welfare determinants; cognitive ethology; animal sentience, self-awareness; and animal consciousness, feeling, and suffering. Duncan and Petherick (1991) have distinguished between needs and desires, sensing or detecting, feeling and perceiving, memory and learning (expectation or anticipation), recall, and awareness. However, animal welfare assessment at farm level can be used as an advisory tool by farmers, as source of information for legislation and as a component of quality assurance schemes for consumers (Napolitano *et al.* 2005; Webster, 2005; Vucinic, 2006). Welfare is multidimensional and it cannot be measured directly, rather it is inferred from external parameters. Therefore, different methods of on-farm monitoring of animal welfare have been developed (Johnsen *et al.* 2001). Animal welfare (AW) can vary substantially between similar production systems indicating the major influence of management and it cannot be measured directly but needs to be assessed through indirect indicators (Rousing, 2003; Sørensen *et al.* 2003). In fact, productivity can be used as an indirect measure of animal welfare (Waiblinger *et al.* 2002; Breuer *et al.* 2003). In high-performing dairy herds, cattle that have a positive relationship with their handlers tend to move more quickly into the milking parlor, have smaller flight zones, and are less nervous and more settled (Breuer *et al.* 2000; Hemsworth *et al.* 2000; Waiblinger *et al.* 2002).

Adopting this approach to animal care and management can result in greater ease and efficiency of management as well as reduced production losses and, in some cases, increased productivity. A decrease in productivity, such as a drop in milk yield, can indicate a welfare problem. Likewise, decreases in reproductive rates or increases in mortality or morbidity should be clear signs that the welfare of livestock is declining. Illness and injury can indicate poor welfare. Other symptoms of problems are changes in behavior; animals that are lethargic, unwilling to move, or that have become aggressive are unlikely to be doing well (Pawelek and Croney, 2003). The physiological and behavioral responses of dairy cattle to stress can reduce their productivity, their health and their welfare. Dairy cattle that have been selected for high milk production seem particu-

larly susceptible to stress and are at more risk of behavioral, physiological and immune problems and so require higher levels of care and management.

Therefore, the main aims of this research were to identify welfare issues facing Tunisian dairy cattle and investigate whether indicators are associated with measures of welfare and performance efficiency.

MATERIALS AND METHODS

Farms and animals
This study involved the collection of data from dairy farms. The study focused on the Holstein Friesian breed, as the majority of dairy cows in Tunisia. 35 dairy farms located in four Tunisian provinces (Nabeul, Sousse, Monastir and Mahdia) were selected from a sample of 50 cattle farms that responded to a questionnaire. All farms had more than 20 dairy cows to ensure that dairying was the main enterprise, and all were using the services of a national milk recorder. The sample was then taken randomly from the farms that fulfilled these criteria. There were three types of loose housing: cubicle housing (16), straw bedding pen (15) and straw flow pen (4). Farms were visited twice: once in the spring (approximately corresponding to the end of winter housing) and once in the autumn. On all farms, the rearing method was similar (artificial insemination, calves being separated from the mother at the age of 1 to 7 days and fed by man).

Thus all cows were artificially reared and suckled by man, giving all cows a certain degree of habituation to and contact with farmers. A total of 350 Tunisian Holstein cows (46%) heifers (H) and (54%) cows (C) were included in the study.

Assessment of animal welfare indicators
Welfare measurements should be based on knowledge of the biology of the species and, in particular, on what is known of the methods used by animals to try to cope with difficulties and of signs that coping attempts are failing. The measurement and its interpretation should be objective. Performance and behavior measurements and behavior tests were performed to show whether the animals were adapting to the production system or whether the animals showed any signs of strain. Animal behavior of 10 cows randomly assigned was recorded through one visit in each farm.

Milk yield
Data on milk traits (production, fat and protein) of seven consecutive years (2002-2008) were obtained from the official recordings of the farm. Cows which were controlled more than 10 successive times during complete 305-days lactation were considered. Milking was carried twice daily.

Fertility

Calving to first service interval (CFSI), calving interval (CI), calving to conception interval (CCI), and number of services per conception (NSC) were extracted from the record of individual cows in each farm. Farmers were also asked about aspects of their management system relating to age at first calving of heifers and their management of reproductive health and fertility.

Mastitis and somatic cell counts (SCC)

As all the farms were using the services of national milk recorders, somatic cell counts were extracted from the databases for all cows on the farm. Only the first three lactations were considered. Data contained multiple somatic cell count (SCC) and the number of cases of mastitis. In accordance with the standard practice for the assessment of somatic cell count, SCC were log-transformed and only cows with 5 or more test-day records were included in the analysis. Lactation number of the cow, the milk yield of the cow, the stage of lactation and the season of calving are all factors known to affect somatic cell count, so they were all included in the analysis. The age of the cow is also known to affect SCC. The total number of cases of mastitis and the number of cows which were treated twice or more were calculated. As many cows received repeated treatments for mastitis, it was necessary to use a criterion to define what a new case was, and what a repeated treatment was. Any treatment started on a new quarter was considered a new case. Any re-treatment of a single quarter within a period of 8 days was considered a repeated case, and greater than 8 days was considered a new case. The number of cases was converted to cases / cow-year for analysis.

Body condition scoring

Body condition scoring is a method of evaluating fatness or thinness in cows according to a five-point scale and using the score to fine-tune dairy herd nutrition and health. Visual and tactile appraisals are necessary. Body condition scores were recorded for all milking cows on the farms. A five-point body condition score system was used, in which a score of 1 was very thin, and a score of 5 was very fat. These are extreme scores and should be avoided. A condition score of 2.5 is thought to be acceptable for lactating Holstein dairy cows.

Human–animal relationship

Human–animal relationship was evaluated through avoidance distance. Its measurement was inspired from the method of Waiblinger *et al*. (2003) and it consists of estimating this distance at the feeding rack (ADF) and inside the stall (ADS). The test person approaches slowly to the

animal and the distance was calculated at the moment of withdrawal of the animal or at the moment of touching.

The test person went slowly to a central place of the stable and stayed there for 10 min. The number of the cows approaching the test person until touching was recorded after 10 min. The number of animals that touched by the test person within the 10 min test was calculated as percentage of the animals standing (AM10).

Lameness scoring

Lameness is painful to the animal, it is a serious welfare issue as cows suffer and is costly to the dairy farm business. Locomotion scoring is based on the observation of cows standing and walking (gait), with special emphasis on their back posture (Table 1).

Table 1 Description of the scale used for scoring lameness (Sprecher *et al.* 1997)

Score	Clinical description	Description
1	Normal	Stands and walks normally with a level back. Makes long confident strides.
2	Mildly Lame	Stands with flat back, but arches when walks. Gait is slightly abnormal.
3	Moderately Lame	Stands and walks with an arched back and short strides with one or more legs. Slight sinking of dew-claws in limb opposite to the affected limb may be evident.
4	Lame	Arched back standing and walking. Favoring one or more limbs but can still bear some weight on them. Sinking of the dew-claws is evident in the limb opposite to the affected limb.
5	Severely Lame	Pronounced arching of back. Reluctant to move, with almost complete weight transfer off the affected limb.

Statistical analysis

The data obtained was statistically analyzed using the SAS statistical package, version 9.1 for Windows (SAS, 1996). Spearman correlation was used to determine relationships between variables.

Differences in mean values and proportions per farm were respectively examined with t-test and Fisher's exact test. Analysis of variance (ANOVA) using the General Linear Models procedure with Duncan and t-test (least-significant-difference, LSD) was used for comparison of avoidance distances. Differences of $P<0.05$ were considered statistically significant. For lameness score, a screening process was used whereby each explanatory variable was tested in a univariate analysis.

For SCC, hock damage and some aspects of behavior, a LMM (Linear Mixed Models) were used (data had normal distributions, or could be transformed to give a normal distribution).

RESULTS AND DISCUSSION

Milk production

The average 305-d lactation milk yield was 5953 kg (with 3.46 and 3.16% content of milk fat and protein, respectively). On average, milk yield at the peak was about 25 kg, and there were a few cows with production exceed 35 kg. We noted that average milk production varies with changes in herd size. Indeed, according to this study, larger herds showed serious losses in production as herd size increased. In opposition, smaller herds were less affected as herd size varied. On the other hand the lower value of fat composition indicated a poor health and therefore a poor welfare. Multivariate analyses with the GLM procedure revealed herd size as significant influence on milk production (coefficient of determination r^2=0.504).

Somatic cell count

Selection against mastitis in dairy cattle is currently underway in several countries. In the present research, the average somatic cell counts amounted to 427.3 ± 90.12. Smaller farms had a lower somatic cell count. SCC increased with lactation number (P<0.001) and varied with stage of lactation in a quadratic manner (P<0.001). SCC was highest in the autumn period (P<0.001) and it was associated with cow milk yield (P<0.001). Herd size also affected SCC. In fact, with larger group sizes having the lowest cell counts (F=3.20, P<0.05). However, the season of calving was not significant (P=0.09).

Mastitis can be a painful disease of dairy cows and its current incidence and prevalence in the present study still give cause for great concern.

Reproductive performance

The main fertility traits used were calving interval (CI), calving to conception interval (CCI), calving to first service interval (CFSI), and number of services per conception (NSC).

Fertility traits were 444 ± 101.5, 154 ± 78.4, 82 ± 56.8 days and 2.1 ± 1, respectively for CI, CCI, CFSI and NSC. Cows were on average 6.0 ± 1.0 years old. (Table 2)

Body condition (BC) scoring

Body condition is a subjective assessment of the amount of fat, or amount of stored energy, a cow carries. In this study, BC ranged from 1.25 to 4 (lactating cattle). The majority of cows were BC score 2.5 (50% cows). The majority of dry cows were BC score 2.75 (65% cows), ranging from BC score 1.5 to 4. We considered a BC score of 2 or less to be classified as 'thin'. The mean number of lactating cows in this category on all farms was 18.9 ± 1.9%, however, this ranged from 1% to 57% of the herd. Body condition affects productivity, reproduction, health and longevity of dairy cows.

Human-animal relationship

Human-animal relationship was measured by avoidance distance. The variation in the response of animals to the avoidance distance test is shown in table 4. Individual avoidance distances ranged from 0 to 1.5m, and the percentage of animals that could be touched on a farm ranged from 41 to 97%. A significant difference in age between farms was found (P=0.002).

Table 2 Means of somatic cells count, production and reproduction parameters

Farms (n)	Cows (n)	MY (kg)	SCC (1.000)	CI (days)	CFSI (days)	CCI (days)	NSC	Age (years)
All farms	35	5953	427.3	444	82	154	2.1	6
1-10	16	5678[a]	447[a]	478[a]	87[a]	159[a]	2.3[a]	6.3[a]
11-20	12	6054[b]	387[b]	437[b]	78[b]	147[b]	1.8[ab]	6.0[ab]
>20	7	6247[b]	378[b]	435[b]	73[b]	145[b]	1.6[b]	5.8[b]

MY: milk yield; SCC: somatic cell count; CI: calving interval; CFSI: calving to first service interval; CCI: calving to conception interval and NSC: number of services per conception.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Table 3 Descriptive statistics of the different measures calculated for the avoidance distance at the feeding place test (ADF)

	Mean	Median	SD	Min-Max	25%-75%[a]	n
Individual level						
ADF	0.13	0.07	0.141	0-1.5	0.05-0.2	-
Farm level						
ADF mean	0.13	0.14	0.034	0.08-0.18	0.11-0.16	10
ADF median	0.08	0.07	0.035	0.05-0.15	0.05-0.10	10
ADF % touch	61.45	50.75	10.72	39.8-70.9	42.5-62.5	10
ADF %>0.2 m	17.4	18.7	8.9	1.8-29.2	9.1-25.1	10

[a] 25% and 75% percentile.
SD: standard deviation.

Farms differed significantly with respect to individual avoidance distances (P<0.001) with a minim farm median of 0.05 m and a maximum farm media of 0.15 m.

Table 4 Avoidance distance dairy heifers (H) or cows (C) when tested in the feeding rack (ADF) or inside the stable (ADS) (Means±SEM)

	Avoidance distance (m)		
	Low	Medium	High
ADF-H	0.63±0.07	0.45±0.15	0.47±0.08
ADF-C	0.28±0.01	0.35±0.06	0.26±0.14
ADS-H	1.05±0.10	1.09±0.44	1.01±0.9
ADS-C	0.89±0.16	0.74±0.17	0.88±0.12

No differences were found with proc GLM (T-test+LSD) (P<0.05).

There was a low significant correlation between the avoidance distances of individual animals and age (r=-0.14, P=0.015). At farm level, none of the ADF farms measures was significantly related with mean age of cow (P>0.05) (Table 3).

Analysis of variance showed a significantly difference (P<0.05) between cows and heifer regarding avoidance distance. We conclude that cows have an ADF of 0.33 ± 0.17 m which be considered short compared to those of heifers (0.56±0.37 m), but no significantly difference (P=0.11) regarding ADS, indeed they have similar behavior in the stall. The proportion of animals with ADF0 were 22% and 31% in heifers and cows, respectively and those of animals that tolerated to be touched for 3 seconds and more (ADF0≥3s) were 24% and 50% in heifers and cows, respectively (Table 4).

Lameness

Foot lameness in the dairy cow is a painful condition that can lead to a great deal of suffering, and it is a very visible well-being issue as well as a production and economic issue. Regarding lameness, it had a reduced proportion, only 19 cows of 350 (5.4%) showed moderate lameness. Our results were better than finding of who reported a percentage of cows affected by lameness ranging from 10 to over 50%.

We see that in both lame and nonlame cows, the greatest proportion of time was spent grazing (~34%), followed by lying with or without ruminating (approximately 29 and 18%, respectively), with <10% time spent in each of the remaining behavioral states (Figure 1).

Throughout, lame and nonlame cows spent similar proportions of time grazing, drinking, or ruminating, but lame cows spent less time elevated on their feet (includes standing with or without ruminating, drinking, grazing and walking) and lay down for longer (includes lying with or without rumination). In both lame and nonlame cows, from early morning to midday to evening, the proportion of time spent grazing or drinking increased, whereas time for totals of ruminating, lying, or standing decreased; walking was unaffected by period of day (Figure 1).

In the past, farm animal welfare has been considered primarily in relation to maximization of productivity. Fox (1984) states that there are no clear-cut correlations between productivity and animal welfare.
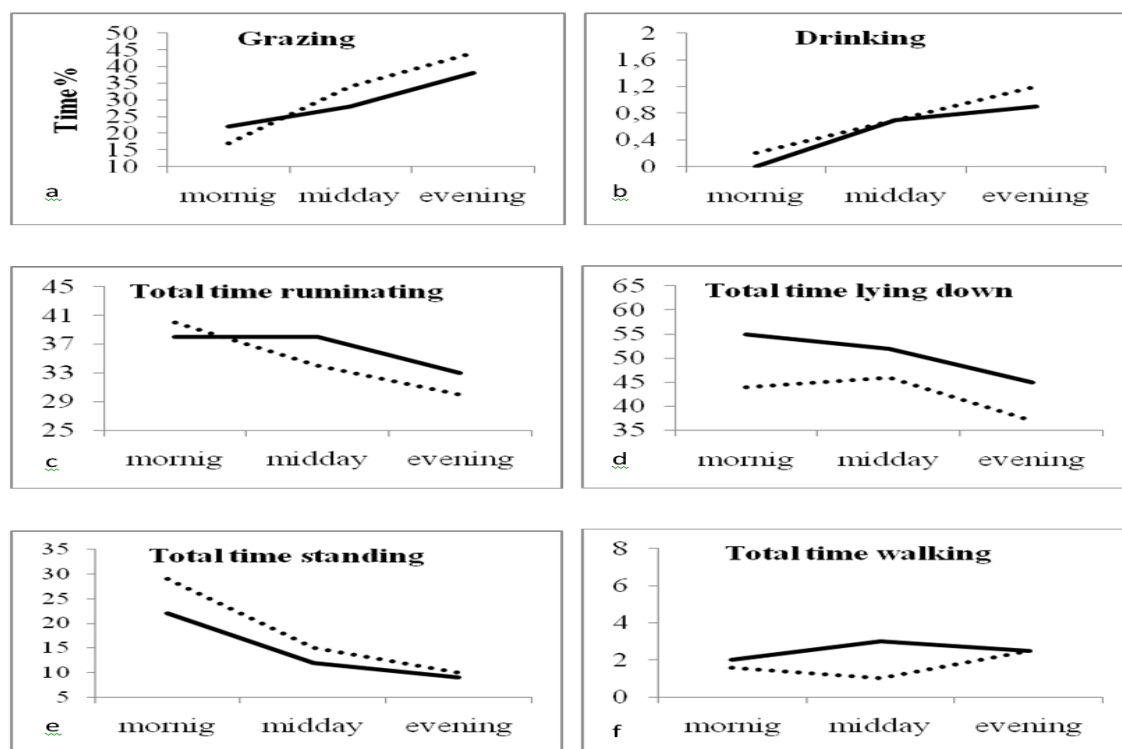
Figure 1 Daily time budgets for lame or nonlame during the morning, midday, and evening, including proportion of scan samples (%) spent a) grazing, b) drinking, c) ruminating c, d) lying down, e) standing, and f) walking

He claims, however, that neglecting the welfare side of farm animal science by making productivity the sole criterion of sound husbandry practices can be counterproductive. In addition to productivity, criteria that should be considered in assessing welfare or well-being are animal behavior, health, musculoskeletal soundness (lameness), reproduction, immune status, and physiological endpoints (Albright, 1987; Zimbelman, 1991). It is vital both for the health and well-being of the animals involved and for the financial future of the farming industry that an increasing critical interest should be taken in the mixture of economic, scientific, ethical, aesthetic, and practical concepts that make up the complex subject of animal welfare, and that action should be taken on the new knowledge and ideas thus gained (Ewbank, 1988).

Milk yield

The results of the current study showed that milk production varies thanks to improvement selection goal, feeding strategies, milking systems, health programs and breeding systems and management. Significant correlations have been found between human-animal interactions and milk yield in dairy cows, this is agree with results of some studies (Breuer *et al*. 2000; Hemsworth *et al*. 2000; Waiblinger *et al*. 2006). The main items that influence the comfort of a dairy cow include housing condition bedding, flooring, and ventilation (Hristov *et al.* 2007), nutrition, water quality, sanitation (DEFRA, 2003; Webster, 2005) and milking equipment. However, many welfare problems are the consequence of a non-adaptation of the animal to the production system. Comfort and cleanliness of animals is dependent not only on amount and type of bedding, but also in animal stocking density, type of shelter, temperature and humidity levels.

Mastitis

Mastitis is considered to be one of the most important health problems in dairy cattle (Heringstad *et al*. 2005). It is reaming a great problem in Tunisian dairy farms as well as many other countries. According to Harmon (1994) clinical mastitis is characterised by pain in the udder, milk with an abnormal appearance and, in some cases, increased rectal temperature and even death. Furthermore, we noticed associations between hygiene scores and udder health parameters and an interaction between stockperson and mammary gland health. Hence, mastitis, however it occurs, is a severe welfare problem. In a 1990 study of 370 cow herds and 45, 133 cows, Oltenacu *et al.* (1990) found that trampled teats and udder injuries were the most serious risk factors for clinical mastitis in tied cows. Oltenacu and Ekesbo (1994), studying Swedish Friesian cows, found that high production predisposed cows for mastitis and that the risk of mastitis

was greater for calving in July and August and increased with age at calving.

Fertility

As selection has led to higher milk production per cow, there have been steady increases n reproductive problems. This result was confirmed by Moberg (2000) and Kaltas and Chrousos (2007) who concluded that during stress, the reproductive axes may be inhibited at several levels. Royal *et al.* (2000) noted that the calving rate of the modern dairy cow is declining at approximately 1% per year and first service conception rates are below 40%. Some studies noted a marked decline in reproductive performance in dairy herds over the past 25 to 30 years. They described a 1998 report on over 70 Kentucky dairy farms in which average days open had increased by 27 days between 1976 and 1996 and the number of services per pregnancy increased from 1.62 (with a 62% conception rate) to 2.91 (with a 34% conception rate).

Human-animal relationship

The analysis of variance showed a significant difference at avoidance distance between cows and heifers. This difference can be explained by a good habituation and adaptation of cows through farmer's attitudes during milking and feeding practices and the intensity of visits and how to treat animal. These results are in agreement with those of Garcia (2009) and Waiblinger *et al.* (2003) who did not found consistent influence from age on avoidance distance, since there were herds with positive and negative Spearman correlation, yet most of them were very low and not significant. ADS correlated moderately with ADF (0.49, P<0.05), supporting the reliability of the two tests, although Windschnurer *et al.* (2008) found a stronger correlation (0.7-0.9) in a study on 16 commercial dairy farms. The greater distances in ADS test were expected, since ADS was tested immediately after ADF on the same animal. Waiblinger *et al.* (2003) found a strong relationship between animals' reactions to humans, particularly avoidance distance inside the stable, and the continuity, quality and quantity of daily contact and handling, and with the frequency of friendly interactions with the farmer (human-animal interactions). Other authors also revealed negative associations between avoidance distances and positive behavior of farmer in dairy farms (Hemsworth *et al.* 2000; Windschnurer *et al.* 2009). Accordingly, there are several evidences that positive interactions ease handling and milking (increase productivity) and can reduce mastitis by promoting adequate milk flow, which has, additionally to improved welfare, an economic impact (EFSA, 2009).

Comparing the results of the present study with the ones from a protocol developed by Whay *et al.* (2003), where the

shortest distance between observer and cow range from 0.6 to 1.1 m. Programs that aim to improve stock people's attitude and behavior toward dairy cattle can reduce flight distance from humans and increase milk (protein and fat) yield (Hemsworth *et al.* 2002). Furthermore, the attitude of the stockperson towards interacting with farm animals is an important determinant of the stockperson's behavior and thus the animal's fear of humans (Hemsworth, 2004; Waiblinger *et al.* 2006). The results confirm our hypothesis, that the avoidance distance validly reflects the human-animal relationship. This is in line with earlier results, where avoidance distance was correlated with the behavior of the farmer (Waiblinger *et al.* 2002). In experimental studies, avoidance reactions of cattle were influenced by previous experience of positive or negative handling (Munksgaard *et al.* 2001; Hemsworth, 2004; Waiblinger *et al.* 2006). The average age of the cows did not confound the assessment of human–animal relationship on the farms in our study. Also within farms, there was no consistent influence of the age of the cows on avoidance distance.

Body condition scoring

An average score of 3 is the most desirable for the majority of the herd. A score with a plus or minus indicates a borderline body condition. A body condition score of 1.5 is not desirable because it indicates severe lack of adequate nutrition. A body condition score of about 3.0 should be typical of a cow recovering body reserves. A body condition score of 3.5 may be the most desirable in late lactation. Studer (1998) explained that high producing cows whose body condition score declines by 0.5 to 1.0 during lactation often experience anoestrus. However, a loss of condition score of about 1.0 during lactation was normal in the review presented by Broster and Broster (1998) and Popescu *et al.* (2009). Dechow *et al.* (2001) found that higher body condition scores were favorably related genetically to reproductive performance during lactation. While higher body scores during lactation were moderately negatively related to milk production, both genetically and phenotypically.

Lameness

Good health is considered a prerequisite for welfare. Bovine lameness represents a major health problem for the dairy industry. A significant percentage of dairy cattle (59%) have severe lameness, this can be a sign of poor overall welfare standards within the herd. Hristov *et al.* (2008) noticed that lameness is indisputably the major welfare problem for the dairy cow. Our findings are in agreement with those of Webster (2005) who reported that half the cows go lame in any one year and 20% are lame at any one time. Lameness in any cow is usually a sign that they are in pain, ill-health and discomfort.

It clearly affects cow welfare, as well as their performance and production (Bergsten, 2001; Ward, 2001; DEFRA, 2003; Hristov *et al.* 2008). Lameness in dairy cows impacts negatively on herd welfare and productivity. It is thought to be closely associated with avoidance of pain caused by limb lesions and, particularly in dairy cattle, by hoof lesions (Dyer *et al.* 2007). It certainly stands out as a consequential and complex welfare problem in dairy cattle (Bergesten, 20001; Rajkondawar *et al.* 2001; Ward, 2001). Leach *et al.* (2008) advise that a limited number of available cubicles are a high risk factor for lameness; in addition, deep bedding and soft lying surface play a key role promoting comfort and reducing lameness. Comparing lameness prevalence in this study with the one from a protocol developed by Whay *et al.* (2003), where categories A (best) to E (worst) graded the welfare of 53 dairy farms, the E category (lameness prevalence of 30-50%) would be the most adequate to classify the studied sample if only cows (59%, 95% CI=42-75%) were considered, or D category (24-30%), if both cows and heifers were counted (27%, 95% C=18-38%). Lameness prevalence was the major welfare problem identified within the studied parameters. Silva *et al.* (2008) have also pointed out hock lesions as a major welfare problem in a study of 50 Northwest Portuguese dairy farms. The current study demonstrated that lame cows spend less time elevated on their feet, due in part to spending less time standing and walking compared with non lame cows. This is in agreement with the results of Almeida *et al.* (2008) and Gonzales *et al.* (2008) who found that lameness significantly decreases feeding time. As shown in many other studies, the age of the cow and the time of year have a large effect on levels of lameness. Lameness prevalence was 12-87% with the mean value of 27 ± 17%. Esslemont and Kossaibati (1996) reported 24% lameness in a survey of 90 herds in 1992-1993, while in another survey, performed on 50 farms during 1995-1996, lameness reached 38%. Herd lameness has been estimated at 22% by recent studies (Whay, 2003) and Wisconsin, USA (Cook, 2003). Our findings of lameness (23%) are in accordance with these authors.

CONCLUSION

Considering that welfare is the result of physical conditions and physiological and psychological mechanisms, which influence livability, growth, reproduction, production, health and behaviour, the actual state of welfare of an animal is the result of the integration of the above mentioned processes. This paper concluded that the most important hazards in relation to animal welfare were mastitis, human-animal relationship and lameness. The reductions in productivity have been considered as an indicator of poor wel-

fare. However, effect on welfare which can be described include those of disease, injury, beneficial stimulation, social interactions, housing conditions, deliberate ill treatment, human handling, various mutilations, veterinary treatment or genetic change by conventional breeding or by genetic engineering. It seems that lameness was the major welfare problem within the studied parameters. Generally, avoidance distance was short, which can be an indicator of a good human-animal relationship and reflect good farming. While global animal welfare level was considered acceptable in the present study using based-animal measures. But there is still a need for a revision of the prevention program for lameness to address its high prevalence in high-producing cows.

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REFERENCES

Ajkondawar P.G., Neerchal N., Varner A.M., Erez B., Lefcourt M.A., Dyer M.R. and Tasch U. (2001). Development of a bovine lameness index that correlates visual lameness scores to measurable limb movement variables: a pilot study. *J. Anim. Sci.* **79,** 16-23.

Albright J.L. (1987). Dairy animal welfare: current and needed research. *J. Dairy Sci.* **70,** 2711-2731.

Almeida P.E., Weber P.S.D., Burton J.L. and Zanella A.J. (2008). Depressed DHEA and increased sickness response behaviours in lame dairy cows with inflammatory foot lesions. *Domest. Anim. Endocrinol.* **34,** 89-99.

Bergsten C. (2001). Effects of conformation and management system on hoof and leg diseases and lameness in dairy cows. *Food Anim. Practice.* **17,** 1-23.

Breuer K., Hemsworth P.H. and Coleman G.J. (2003). The effect of positive or negative handling on the behavioural responses of nonlactating heifers. *Appl. Anim. Behav. Sci.* **84,** 3-22.

Breuer K., Hemsworth P.H., Barnett J.L., Matthews L.R. and Coleman G.J. (2000). Behavioural response to humans and the productivity of commercial dairy cows. *Appl. Anim. Behav. Sci.* **66,** 273-288.

Broster W.H. and Broster V.J. (1998). Body score of dairy cows. *J. Dairy Res.* **65,** 155-173.

Broom D.M. (1986). Indicators of poor welfare. *British Vet. J.* **142,** 524-526.

Cook N.B. (2003). Prevalence of lameness among dairy cattle in Wisconsin as a function of housing type and stall surface. *J. American Vet. Med. Assoc.* **223,** 1324-1328.

Dechow C.D., Rogers G.W. and Clay J.S. (2001). Heritabilities and correlations among body condition scores, production traits, and reproductive performance. *J. Dairy Sci.* **84,** 266-275.

DEFRA (Department of the Environment, Food and Rural Affairs). (2003). Code of Recommendations for the Welfare of Livestock: Cattle. HMSO, London.

Duncan I.J.H. and Petherick J.C. (1991). The implications of cognitive processes for animal welfare. *J. Anim. Sci.* **69,** 5017-5022.

Dyer R.M., Neerchal N.K., Tasch U., Wu Y., Dyer P. and Rajkondawar P.G. (2007). Objective determination of claw pain and its relationship to limb locomotion score in dairy cattle. *J. Dairy Sci.* **90,** 4592-4602.

EFSA (2009). Scientific opinion of the panel on animal health and welfare on a request from the European Commission on welfare aspect of the main systems of stunning and killing of farmed Atlantic salmon. *EFSA. J.* **10(12),** 1-3.

Esslemont R.J. and Kossaibati M.A. (1996). Incidence of production diseases and other health problems in a group of dairy herds in England. *Vet. Rec.* **139,** 486-490.

Ewbank R. (1988). Management and Welfare of Farm Animals. 3rd Ed. Bailliere Tindall, London.

Fox M.W. (1984). Farm Animals Husbandry, Behavior and Veterinary Practice: Viewpoints of a Critic. University Park Press, Baltimore, MD.

Garcia E.F. (2009). Oestrous intensity-a relevant indicator for animal well-being in high-producing dairy cows? Ph D. Thesis. Faculty of Veterinary Medicine of the Technical University of Lisbon.

Gonzales L.A., Tolkamp B.J. and Kyriazakis I. (2008). Changes in feeding behaviour as possible indicators for the automatic monitoring of health disorders in dairy cows. *J. Dairy Sci.* **91,** 1017-1028.

Harmon R.J. (1994). Physiology of mastitis and factors affecting somatic cell counts. *J. Dairy Sci.* **77,** 2103-2112.

Hemsworth P.H. (2004). Human-livestock interaction. Pp. 21-38 in The Well Being of Farm Animals, Challenges and Solutions. G.J. Benson and B.E. Rollin Eds. Blackwell Publishing, Iowa, USA.

Hemsworth P.H., Coleman G.J., Barnett J.L. and Borg S. (2000). Relationships between human-animal interactions and productivity of commercial dairy cows. *J. Anim. Sci.* **78,** 2821-2831.

Hemsworth P.H., Coleman G., Barnett J.L., Borg S. and Dowling S. (2002). The effects of cognitive behavioural intervention on the attitude and the behaviour of stockpersons and the behaviour and productivity of commercial dairy cows. *J. Anim. Sci.* **80,** 68-78.

Heringstad B., Chang Y.M., Gianola D. and Klemetsdal G. (2005). Genetic association between susceptibility to clinical mastitis and protein yield in Norwegian dairy cattle. *J. Dairy Sci.* **88,** 1509-1514.

Hristov S., Stanković B., Zlatanović Z., Joksimović-Todorović M.V. and Davidović V. (2008). Rearing conditions, health and welfare of dairy cows. *Biotechnol. Anim. Husband.* **24(1-2),** 25-35.

Hristov S., Stanković B., Joksimović T.M., Bojkovski J. and Davidović V. (2007). Uticaj toplotnog stresa na proizvodnju mlečnih krava. *Zbornik Naučnih Radova.* **13(3-4),** 47-54.

Hughes B.D. (1976). Behavior as an index of welfare. Pp. 1005-1012 in Proc. 5th European Poult. Conf. Malta.

Johnsen P.F., Johannesson T. and Sandøe P. (2001). Assessment of farm animal welfare at herd level: many goals, many methods. *Acta. Agric. Scandinavica*. **30,** 26-33.

Kaltas G.A. and Chrousos G.P. (2007). The neuroendorinology of stress. Pp. 303-318 in Handbook of Psychophysiology. J.T. Cacioppo, L.G. Tassinary and G.G. Berntson Eds. Cambridge University Press, Cambridge.

Leach K.A., Huber J., Whay H.R., Winckler C., March S. and Dippel S. (2008). Assessing lameness in tied cows. Pp. 126-128 in Proc. 15th Int. Conf. Lameness in Ruminants, Kuopio, Finland. Savonia Univ. Appl. Sci, Kuopio, Finland.

Moberg G.P. (2000). Biological response to stress: implications for animal welfare. Pp. 1-21 in Biology of Animal Stress. Mench and G. Moberg Eds. CAB International, J.A. Oxon.

Munksgaard L., DePassille A.M., Rushen J., Herskin M.S. and Kristensen A.M. (2001). Dairy cows' fear of people; social learning, milk yield and behaviour at milking. *Appl. Anim. Behav. Sci.* **73,** 15-26.

Napolitano F., Grasso F., Bordi A., Tripaldi C., Saltalamacchia F., Pacelli C. and De Rosa G. (2005). On-farm welfare assessment in dairy cattle and buffaloes: evaluation of some animal-based parameters. *Italian J. Anim. Sci.* **4,** 223-231.

Oltenacu P.A., Bendixen P.H., Vilson B. and Ekesbo I. (1990). Tramped teats-clinical mastitis disease complex in tied cows. Environmental risk factors and interrelationships with other diseases. *Acta. Vet. Scandinavica*. **31(4),** 471-478.

Oltenacu P.A. and Ekesbo I. (1994). Epidemiological study of clinical mastitis in dairy cattle. *Vet. Res.* **25(2-3),** 208-212.

Pawelek R. and Croney C. (2003). Animal welfare. Understanding and addressing issues related to the well being of livestock. Oregon State University Extension Service.

Popescu S., Borda C., Hegedus I.C., Sandru C.D., Spinu M. and Lazar E. (2009). Dairy cow welfare assessment in extensive breeding systems. *Lucrări Ştiinţifice Medicină Veterinară*. **13(2),** 23-29.

Rousing T. (2003). Welfare assessment in dairy cattle herds with loose-housing cubicle systems. Development and evaluation of welfare indicators. Ph D. Thesis. Danish Institute of Agricultural Science. Denmark.

Royal M., Mann G.E. and Flint A.P. (2000). Strategies for reversing the trend towards subfertility in dairy cattle. *Vet. J.* **160(1),** 53-60.

SAS Institute. (1996). SAS®/STAT Software, Release 6.11. SAS Institute, Inc., Cary, NC.

Silva L.W., Smith R.F., Routly J.E., Jones D.N., Morris M.J. and Dobson H. (2008). Lameness, activity time-budgets, and estrus expression in dairy cattle. *J. Dairy Sci*. **91,** 4552-4559.

Sorensen J.T., Bonde M.K., Møller S.H. and Rousing T. (2003). A concept for assessing animal welfare at farm level as a farm management tool. Pp. 728-730 in Proc. 10th Int. Symp. Epidemiol. Econ. Vina del Mar, Chile.

Sprecher D.J., Hostetler D.E. and Kaneene J.B. (1997). A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. *Theriogenology*. **47,** 1179-1187.

Studer E. (1998). A veterinary perspective of on farm evaluation of nutrition and reproduction. *J. Dairy Sci*. **81,** 872-876.

Vucinic M. (2006). Ponašanje, dobrobit i zaštita životinja. Fakultet Veterinarske Medicine, Beograd.

Waiblinger S., Boivin X., Pedersen V., Tosi M.V., Janczak A.M., Visser E.K. and Jones R.B. (2006). Assessing the human–animal relationship in farmed species: a critical review. *Appl. Anim. Behav. Sci.* **101,** 185-242.

Waiblinger S., Menke C. and Coleman G. (2002). The relationship between attitudes, personal characteristics and behaviour of stockpeople and subsequent behaviour and production of dairy cows. *Appl. Anim. Behav. Sci.* **79,** 195-219.

Waiblinger S., Menke C. and Fölsch D.W. (2003). Influences on the avoidance and approach behaviour of dairy cows towards humans on 35 farms. *Appl. Anim. Behav. Sci*. **84,** 23-39.

Ward W.R. (2001). Lameness in dairy cattle. *Irish Vet. J*. **54,** 129-139.

Webster J. (2005). Animal Welfare: Limping Towards Eden. Blackwell Publishing.

Whay H.R. (2007). The journey to animal welfare improvement. *Anim. Welfare*. **16(2),** 117-122.

Whay H.R., Main D.C.J., Green L.E. and Webster A.J.F. (2003). Assessment of the welfare of dairy cattle using animal-based measurements: direct observations and investigation of farm records. *Vet. Rec*. **153,** 197-202.

Windschnurer I., Schmied C., Boivin X. and Waiblinger S. (2008). Reliability and inter-test relationship of tests for on-farm assessment of dairy cows' relationship to humans. *Appl. Anim. Behav. Sci.* **114,** 37-53.

Zimbelman R.G. (1991). Animal well being: one scientist's point of view. *Prof. Anim. Sci*. **7,** 9-12.