

REPEATABILITY OF SOME ANIMAL-RELATED VARIABLES IN DAIRY COWS AND BUFFALOES

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Abstract

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The aim of this study was to evaluate the intra-observer repeatability of some animal-related variables which could be used in welfare-assessment protocols at farm level. Recordings were performed on seven dairy farms (four for cattle and three for buffaloes). The animals were observed on three occasions at three-week intervals. The variables collected for each animal were behaviour during milking (stepping and kicking), avoidance distance, lameness, and cleanliness. For each farm and each variable, intra-observer repeatability was computed using the Kendall coefficient of concordance (W). A ratio between the variance of the animal and the sum of the latter with the error variance was also calculated using a model of analysis of variance with one factor (animal), to give a further measure of repeatability. These two methods yielded similar results. In particular, in dairy cattle, a high repeatability for avoidance distance, stepping, lameness and cleanliness was observed, whereas for buffaloes avoidance distance and stepping were the repeatable variables.

Keywords: *animal welfare, buffalo, cattle, performance criteria, repeatability, welfare monitoring*

Introduction

Farm animal welfare is an important issue, particularly in Western countries. In these countries, an increasing number of consumers demand high-quality livestock products obtained using methods where animal welfare is considered important.

Different protocols for on-farm monitoring of animal welfare have been developed in Europe (for a review, see Johnsen *et al* 2001). Some of these methods focus on design criteria, which comprise structural and technical elements (space allowance, feeding facilities, etc) and management-related factors such as hygienic and climatic conditions. Others use animal-based variables (performance criteria) dealing with behaviour, health and physiology of the animals. However, a combination of design and performance criteria is generally recommended to obtain a valid assessment of animal welfare (Johnsen *et al* 2001). The indicators to be included in a scheme for on-farm assessment of animal welfare should be valid (meaningful with respect to animal welfare), repeatable (reliable), feasible, and used throughout Europe. This is also one of the main objectives of the European Co-operation in

the Field of Scientific and Technical Research (COST) Action 846 'Measuring and Monitoring Farm Animal Welfare'. Repeatability of a particular variable indicates the relative similarity of measurements performed on one animal on different occasions (Ofner *et al* 2000). If the repeatability is low, the variable has to be assessed several times to obtain a reliable result, hence it is unsuitable for animal welfare monitoring at farm level. The aim of this study was to evaluate the repeatability of some animal-related variables, which could be used in protocols developed for assessing animal welfare at farm level.

Materials and methods

Recordings were performed in seven loose-housed dairy farms (four for cattle and three for buffaloes) equipped with herring-bone parlours and located in the province of Rome (Italy). On each farm, 30–40 animals (15–20 primiparous and 15–20 multiparous) at a lactation stage of 100–160 days were selected. Observations were conducted by a team of eight trained assessors. Four preliminary sessions, conducted in different non-experimental farms, were used to standardise assessments. Experimental animals were observed on three occasions at 15–20 day intervals to obtain a measure of repeatability of the variables described below. For each variable and for each animal, the observation was always performed by the same assessor.

Behaviour during milking

The behaviour of animals in the milking parlour was observed during the afternoon milking. On each observation day, the number of steps (whenever one hoof was lifted less than 15 cm off the ground) and the number of kicks (whenever one hoof was raised at least 15 cm off the ground) were recorded from attachment to removal of cups.

Avoidance distance

This test was performed between 1100h and 1300h. The assessor entered the pen and stood motionless until the animals looked at him. The assessor commenced testing from opposite ends of the longest axis over which the herd was spread, walking slowly (one step per second) toward the animal with one hand held slightly forward (Krohn *et al* 2001). The distance between the assessor and the point at which the cow moved away was recorded and defined as the avoidance distance (Hemsworth *et al* 2000). Following a measurement, the person moved toward the closest, undisturbed and stationary animal, as described above, to conduct the next recording.

Lameness score

The lameness score was recorded after the afternoon milking using a scheme proposed by Breuer *et al* (2000). Data were collected while cows were exiting the milking shed. A score of 0 to 3 was used, where 0 was assigned when the animal was not lame (normal gait), 1 when the cow was mildly lame (slight limp, no head bob), 2 when the cow was lame (clear limp, head bob), and 3 when the cow was very lame (head bob and leg held up for a period of seconds).

Cleanliness score

Animals were scored for cleanliness using a modification of the system described by Krebs *et al* (2001). A scoring chart identified five regions of the body which were rated on a scale with anchor points at each end (0 = clean; 2 = very dirty) and half-point increments. Scores

were subsequently totalled to obtain a single value for each animal. The five regions were: ano-genital; udder (rear view); leg; hind underbelly and udder (lateral view); and thigh. In addition, the inter-observer repeatability was calculated using the scores produced on the same occasion by the eight assessors for 20 dairy cattle on a non-experimental farm.

Statistical analysis

For each farm and each variable, intra-observer repeatability was computed using the Kendall coefficient of concordance (W). A ratio between the variance of the animal and the sum of the latter with the error variance was also calculated using a model of analysis of variance with one factor (animal), as suggested by Ofner *et al* (2000), to give a further measure of the repeatability. In addition, the Kendall's W coefficient was used to evaluate the inter-observer repeatability for the cleanliness score.

Results and discussion

Inter-observer repeatability

The relative similarity of independent observations on animal cleanliness was high, since different observers evaluating the same animals showed a high degree of concordance ($W = 0.877$; $df = 19$; $\text{Chi}^2 = 44.85$; $P < 0.001$). It can be concluded that different observers are likely to produce similarly reliable indications of animal cleanliness.

Intra-observer repeatability

Repeatability of the variables is shown in Tables 1 and 2 (see Kendall's columns). A high degree of repeatability of avoidance distance was observed for both species ($P < 0.05$ to 0.001). The nature of human contacts toward cows can affect their subsequent behavioural response, welfare and milk production. Hemsworth *et al* (2000) found a correlation between stockperson attitude, animal fear and productivity in dairy cows, thus indicating a possible opportunity to reduce fear of humans and increase milk production by targeting stockperson attitudes and behaviour.

Behavioural recordings at milking showed that the repeatability of stepping was high for both buffaloes ($P < 0.05$ to 0.01) and cattle ($P < 0.05$ to 0.001), whereas kicking was less repeatable ($P < 0.10$ to 0.01 and $P > 0.10$ for buffaloes and cattle, respectively). Previous studies have shown that stepping may be considered an indicator of agitation, whereas kicking is more related to aggressiveness. Animal restlessness at milking is a possible source of injury and may be caused by many different factors such as pushing of adjacent cows, lameness, low mineral intakes, presence of haematophagous insects, and poor maintenance of the milking machine. However, Breuer *et al* (2000) found a correlation between human behaviour and cow restlessness during milking, suggesting that at least a component of this animal response to milking may be a response to the stockperson. The presence of aversive handlers during milking has also been shown to increase heart rates, cortisol levels and residual milk (Hemsworth *et al* 2000), which are all expressions of fear and stress.

The evaluation of body cleanliness may give some information on cow comfort and stockpeople's attitude and care for animals. Although this variable is highly dependent on factors such as weather conditions and frequency of straw substitution, in the present study a moderate degree of repeatability was observed for cattle cleanliness ($P < 0.05$ to 0.001) on most cattle farms. Conversely, it was very low for buffaloes on the single farm where this variable was monitored ($P > 0.10$). This latter result is likely to be due to the behaviour peculiar to buffalo of wallowing, aimed at gaining relief from heat stress and dermal parasites.

Table 1 Repeatability computed for three dairy buffalo farms with Kendall's *W* test (*P*-values) or according to the method suggested by Ofner *et al* (2000) (standard deviations of error).

	Farm					
	1		2		3	
	Kendall	Ofner <i>et al</i>	Kendall	Ofner <i>et al</i>	Kendall	Ofner <i>et al</i>
Avoidance distance	—	—	0.70 (0.001)	0.84 (0.86)	0.63 (0.010)	0.72 (0.68)
Stepping	0.51 (0.023)	0.67 (2.76)	0.66 (0.009)	0.78 (2.32)	0.59 (0.019)	0.70 (3.59)
Kicking	0.55 (0.010)	0.70 (0.80)	0.63 (0.014)	0.73 (1.11)	0.48 (0.095)	0.55 (1.22)
Cleanliness score	—	—	—	—	0.29 (0.630)	0.36 (1.34)
Lameness score	—	—	§	§	§	§

§ Statistical analysis was not performed due to lack of values different from 0.

Table 2 Repeatability computed for four dairy cattle farms with Kendall's *W* test (*P*-values) or according to the method suggested by Ofner *et al* (2000) (standard deviations of error).

	Farm							
	4		5		6		7	
	Kendall	Ofner <i>et al</i>	Kendall	Ofner <i>et al</i>	Kendall	Ofner <i>et al</i>	Kendall	Ofner <i>et al</i>
Avoidance distance	0.43 (0.050)	0.63 (1.03)	0.57 (0.011)	0.57 (1.09)	0.59 (0.003)	0.76 (0.79)	0.64 (0.002)	0.70 (0.82)
Stepping	—	—	0.76 (0.001)	0.91 (5.87)	0.64 (0.001)	0.72 (6.19)	0.52 (0.026)	0.55 (4.22)
Kicking	—	—	0.45 (0.130)	0.61 (0.76)	0.35 (0.380)	0.65 (1.14)	§	§
Cleanliness score	0.62 (0.170) ^a	0.37 (2.02) ^a	0.51 (0.035)	0.66 (0.93)	0.68 (0.001)	0.81 (1.04)	0.71 (0.001)	0.81 (0.98)
Lameness score	0.62 (0.140) ^a	0.63 (0.49) ^a	0.43 (0.140)	0.61 (0.74)	0.66 (0.001)	0.82 (0.60)	§	§

^a Only two recordings were performed.

§ Statistical analysis was not performed due to lack of values different from 0.

Although cleanliness can give some indication of cow comfort, it may be less relevant than injuries and disease. In particular, lameness is a major welfare problem for dairy animals, inducing pain and discomfort for long periods. Lameness may be caused by several different factors, such as unbalanced nutrition, flooring, social behaviour and time spent standing (Winckler & Willen 2001). The study of concordance for this animal variable yielded heterogeneous results: the significance of the Kendall's *W* test was low on farms 4 and 5 ($P > 0.10$), whereas it was much higher on farm 6 ($P < 0.001$). However, only two sessions of recording were performed on farm 4, with obvious and evident effects on the level of significance, whereas the state of claws was satisfactory on farm 5 (where only six animals showed a score different from 0) and on farm 7 (where no animals displayed lameness).

The results obtained with Kendall's *W* test were compared with those yielded using the method of Ofner *et al* 2000. The construction of arbitrary clusters of Ofner *et al*'s ratios (below 0.5, within 0.5/0.75 and above 0.75 were considered indicative of low, medium and high repeatability, respectively) and Kendall's *W* significance ($P > 0.1$ = low, $0.1 \geq P \geq 0.01$ = medium, and $P < 0.01$ = high) allowed comparison between the two statistical methods, which resulted in a high degree of agreement (10 out of 16 and 9 out of 9 measures of repeatability were similar for cattle and buffalo farms, respectively).

Animal welfare implications

Based on the present results it seems that for dairy cattle, avoidance distance, stepping, cleanliness and lameness could be conveniently included in a scheme of welfare assessment at farm level. Conversely, for buffaloes, only avoidance distance and stepping produced consistent results. For these animals, cleanliness was not repeatable, possibly as a consequence of their wallowing behaviour, whereas lameness was virtually absent, which may be attributed to either lower genetic predisposition or lower feeding regimen.

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