Determining risk factors for poor hygiene score of dairy cows from UK organic and conventional farms

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Abstract

Farms (n=14) were visited in August and October 2003, and January 2004 (n=28) for assessment of cow hygiene score. Within-observer repeatability of scoring was assessed by duplicate scoring of cows. Hygiene score assessment was found to be repeatable, as indicated by good agreement using weighted kappa (K(*W*)). Cow hygiene scores were compared over time using a generalised linear mixed model (GLMM) analysis of variance. Cow hygiene score increased (cows became more dirty) between August and January, which corresponded to cows being housed in winter. Proportional odds logistic regression (POLR) was used to analyse the factors affecting cow hygiene score at each time point. When all cows were at grass, dry cows were more likely to be in a cleaner score category compared to lactating cows. Cows housed in straw yards were less likely to be in a cleaner score category compared to cows in cubicles. However, organically managed cows in straw yards were more likely to be cleaner then conventional cows in straw yards and, overall when housed, organically managed cows were more likely to be in a cleaner score category compared to conventional cows. Faecal pat consistency did not influence cow hygiene score in final multivariable models. In conclusion, scoring is repeatable and may have relevance to dairy cow health and welfare investigations.

Introduction

Hygiene scoring systems for dairy cows have been developed to record the degree of contamination of different anatomical areas with dirt and faecal matter, thus giving an overall assessment of the cleanliness of the whole animal (Hughes 2001; De Rosa *et al.* 2003). Cow cleanliness may be affected by housing design, bedding type and provision and faecal consistency, which in turn reflect cow nutrition and digestion (Ward *et al.* 2002; Bowell *et al.* 2003; Grove-White 2004). In the UK, organic farming standards stipulate criteria for dairy cow housing and for the feeding of a minimum of 60% of the dry matter intake as forage to provide a basis for optimal dairy cow comfort and health (Anon. 2005). To date, direct comparison of cow cleanliness as part of an animal-based assessment of organic and conventional dairy cow health and welfare has not been attempted in the UK. The study described here aimed to investigate whether cow cleanliness was affected by: 1) Farming system (organic or conventional) and 2) The transition from summer grazing to winter housing. To achieve these aims, a one-observer scoring system was validated and utilised in a longitudinal and cross-sectional study.

Methods

A longitudinal study followed a number of farms through from summer to winter housing, and a larger, cross sectional study assessed a greater number of farms during the winter housing period. Fourteen farms (7 organic and 7 conventional and of approximately equal herd sizes) were visited in August and October 2003 and January 2004 for assessment of the cow hygiene scores. In January 2004, an additional 14 farms (7 organic and 7 conventional) were also visited for a larger cross sectional study. Cow hygiene score was assessed using a modified scoring method (Hughes, 2001). Four anatomical areas were observed on each cow: the flanks, the legs, the tail and the udder, with an overall whole-cow score ascribed based on summation of scores from these sites. Area scores were assigned on a 1 to 5 scale (score 1 = very clean, no dirt; score 5 = heavily soiled with dirt and/or faeces) thus giving the whole-cow score from 4 to 20. One observer determined scores throughout the study. Within-observer repeatability was assessed by duplicate scoring (on the same visit) of 43 lactating dairy cows, without access to the first set of scores. On all herds, a proportion of cows were randomly selected for scoring, based on an estimated expected prevalence of 10% of cows being classed as excessively dirty (Ward *et al.* 2002). Faecal pat consistency was also scored on a five-point scale: 1=very dry, firm and lumpy to 5=extremely loose/diarrhoeic, based on Hughes (2001). Data were analysed using Microsoft Excel and MINITAB (Minitab Inc., 2003, State College, PA). Kappa and weighted kappa (K(W)) (Ersbøll *et al*. 2004) were used to measure the level of the observer agreement in the duplicate scored cows. For K(*W*) agreement (on the main diagonal of a 2x2 table) was weighted as zero, using a weights matrix that increased uniformly for each score disagreement. Cow hygiene scores from herds in the longitudinal study were compared over time using a GLMM (Model 1), where μ is the mean whole-cow hygiene score, F_i is the individual farm effect, T_j is the farm type, M_k is the month effect and $\bullet_{ijk}$ is the residual error term;

$$\text{Cow hygiene score}_{ijk} = \mu + F_i(T_j) + T_j + M_k + \bullet_{ijk}$$

(Model 1)

Factors affecting cow hygiene score each month were analysed by POLR (Model 2) where logit ($p(Y\bullet\ y_j)$) is the log odds of a response in category y_j or below, $\bullet_j$ is the unknown intercept, $\bullet=(\bullet_1-\bullet_k)$ is the effect (slope) of the predictor $X=(X_1-X_k)$;

$$\text{Logit}\ (p(Y\bullet\ y_j)) = \bullet_j + \bullet_1 X_1 + \bullet_2 X_2 + \ldots\ldots. + \bullet_k X_k \qquad j=1,2,\ldots\ldots\ldots, c-1$$

(Model 2)

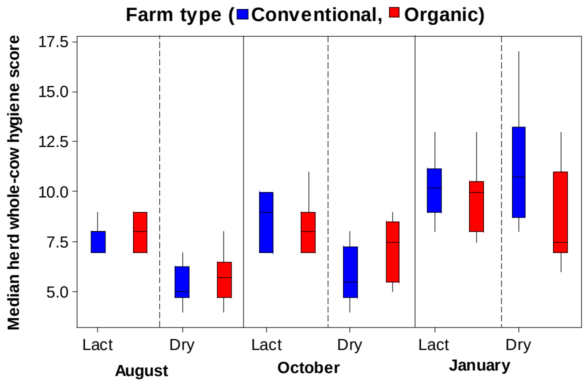
For POLR analyses, the reference outcome is the lower (cleaner) hygiene score; so that odds ratios (OR) relate to the odds of a cow being cleaner. Variables included in POLR analysis were: farm identity, farm system type (organic or conventional), housing system (cubicles or straw yards, January only), housed or at grass (October only), yield group of cows when housed (dry, high, mid and low yielders or 'all lactating cows' if herds housed all lactating cows were together), herd average yield and herd size (both by quartiles) and faecal pat consistency. Cows were classed as lactating or dry when some or all were at grass (August and October). Variables affecting cow hygiene score that were significant ($p<0.2$) at the univariate level were included in the multivariable model. Models were constructed by stepwise backwards elimination. Variables were retained if the change in deviance, calculated using the change in the log-likelihood, was significant ($p<0.05$). Biologically plausible interactions were included when significant. Individual farm identity was nested within farm type (organic or conventional) for multivariable analyses.

Results

Data from duplicate scored cows showed that observer disagreement only occurred by one point for the individual sites of flank, legs, tail and udder. The kappa and *K*(*W*) statistic for whole-cow scores were 0.32 and 0.61 respectively.

Longitudinal study (n=14 farms August, October and January)

Herd-level median cow hygiene scores for each month are shown in Figure 1. Herd yield and herd size were not included in any of the final models as they were co-linear with herd identity. Faecal pat consistency dropped out of all final models. In all models, herd identity had a highly significant effect on cow hygiene score ($p<0.001$). In August, dry cows were more likely to be in a cleaner score category compared to milking cows (OR of 11, 95% confidence interval (CI) 7.60-15.90, p<0.001). In October, organic cows were more likely to be dirtier (OR 0.40, 95% CI 0.18-0.86, p=0.02). Again, dry cows were more likely to be cleaner compared to lactating cows (OR 13, 95% CI 7.75-21.81, p<0.001). An interaction between farm type and cow type indicated that organic dry cows were more likely to be dirtier than conventional dry cows (OR 0.25, 95% CI 0.12-0.51, p<0.001). However, in January, overall, organic cows were more likely to be in a cleaner hygiene score category (OR 8.63, 95% CI 4.24-17.58, p<0.001). High yielders and mid yielders were less likely to be cleaner than ‘all lactating cows’ with OR of 0.30 (95% CI 0.18-0.52, p<0.001) and 0.23 (95% CI 0.13-0.44, p<0.001) respectively. However, there was a significant interaction between farm type (organic or conventional) and lactation group (p<0.001 overall), where organic dry cows were more likely to be cleaner than conventional dry cows (OR 3.26, 95%CI 1.88-5.66, p<0.01). There was a significant increase in cow hygiene score (cows became dirtier) between each month of assessment (overall effect for month, p<0.001), with a significant interaction (p<0.001) between farm system type and month, where organic cows were on average dirtier in August and cleaner in January (Figure 2).



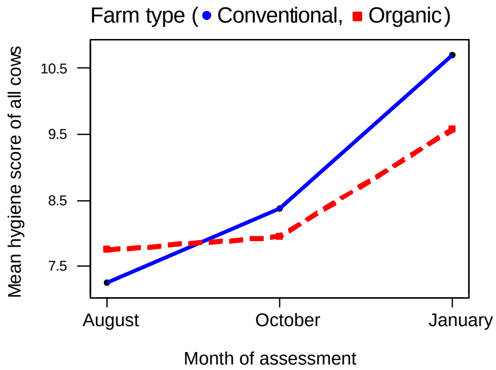


Figure 1 Median monthly cow hygiene score

Figure 2 Farm type x time hygiene score interaction

Cross sectional study (n=28 farms in January)

Overall, organically managed cows were more likely to be in a cleaner score category compared to conventionally managed cows (OR 7.27, 95%CI 3.56-14.86, p<0.001). Both high yielding and mid yielding cows were less likely to be in a cleaner score category compared to ‘All lactating cows’ (OR 0.36, 95%CI 0.21-0.61, p<0.001 and OR 0.42, 95%CI 0.22-0.82, p<0.001 respectively). Housing type remained significant in this larger study group of herds, with cows in straw-yards less likely to be clean (OR 0.30, 95%CI 0.17-0.51, p<0.001). However, significant interaction terms suggested that organically managed cows in straw yards were more likely to be cleaner than conventionally managed cows in straw yards (OR 2.68, 95%CI 1.11-6.46, p=0.03), and organically managed dry cows were more likely to be cleaner than conventionally managed dry cows (OR 2.30, 95%CI 1.30-4.07, p<0.01).

Discussion

The subjective assessment of hygiene score was successfully validated for repeatability. Interpretation of the value of the kappa statistic varies between authors; however, the values obtained in this study would range from fair/poor for the flanks to excellent for the tail (Ersbøll *et al.*, 2004). For whole-cow scores, using K(*W*) did have an effect on the value of the kappa statistic, increasing the value from 0.32 to 0.61. This would make a difference in the interpretation of fair/poor agreement to good agreement. An added complexity was the fact that the whole cow score was a compound score from the four areas. Using POLR, the OR calculated is not an indication of ‘clean’ versus ‘dirty’, rather it gives the odds of a cow being at or below a certain cut-point in the ordinal scale. It was outside the scope of this project to calculate cow stocking density when housed, or to attempt to measure ‘stockmanship’, but this study suggested a number of points. Cows become dirtier in the transition from summer grazing to winter housing, which would be expected, as the cows have greater restriction in space and in their choice of lying areas in housed systems. Dry cows tended to be cleaner than lactating cows in August and October. This effect was reduced when cows were housed. During the grazing period, walking lactating cows to milking and putting them through a collecting yard is likely to increase their exposure to mud and faecal contamination; thus they are dirtier than dry cows. Although farming system has no effect when the cows are at grass, when housed in the winter, organic cows were significantly more likely to be cleaner. Cow lactation group meant high yielders and mid yielders were less likely to be clean, which most likely reflects higher feed intakes and faecal output by higher yielding groups. Cows in straw yards were more likely to be dirty than those in cubicles but despite greater use of straw yards on organic farms, organic cows were more likely to be cleaner than conventional cows in straw yards. This study validated a cow cleanliness scoring system over a wide range of farms, and found that it was both repeatable and a practical technique to use on farm.

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