Factors contributing to the incidence and prevalence of lameness on Czech dairy farms

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ABSTRACT: Twenty-four Czech dairy farms were visited to record lameness prevalence and to identify factors associated with high lameness prevalence at the farm level and/or increased lameness risk at the level of individual cows. All cows were checked for lameness and forty cows per farm were examined for overgrown claws, body dirtiness and skin lesions. The farm environment was scored between 1 (excellent) to 5 (very poor) in three different aspects: floor slipperiness, cow care quality, and housing quality. Data on hoof trimming schedules were obtained from farm managers. Lameness prevalence on farms was in a wide range from 6% to 42% (median 22%). At the farm level, floor slipperiness and poor animal care were associated with high lameness prevalence (Spearman correlations, $P < 0.05$), and the proportion of cows with overgrown claws tended to be associated with it ($P < 0.10$). The reported time schedules of hoof trimming (continuous trimming applied or not; and time elapsed since the whole herd was trimmed) were unrelated to either the prevalence of overgrown claws or the prevalence of lameness. Within farms, cows with overgrown claws and dirty cows were at an increased risk of being lame (multiple logistic regression, $P < 0.05$) and cows with skin lesions tended to be more lame ($P < 0.10$). The risk of lameness had an inverted U-shape dependence on age ($P < 0.05$), with cows at 7–8 years of age being the most endangered by lameness. We conclude that there is a large potential for lameness reduction on some Czech dairy farms through improving the cow care and reducing floor slipperiness, and that within farms, cows with overgrown claws and also dirty cows and cows with skin lesions should be given special attention since they are more likely to get lame.

Keywords: dairy cows; lameness; welfare; housing; hoof care

Lameness is one of the most pressing health, production and welfare problems on intensive dairy farms. Its prevalence varies between 1% and 21% in different studies (Alban, 1995; Clarkson et al., 1996; Manske et al., 2002). Lame cows are in pain, show inappetence, decreased milk yield, and weight loss (Green et al., 2002; O'Callaghan et al., 2003). The behaviour of lame cows is also affected: they are more restless at milking, spend more time lying down and eat more slowly (Hassall et al., 1993; Juarez et al., 2003; O'Callaghan et al., 2003). Lameness is a frequent reason for culling (Booth et al., 2004); for instance, clinical lameness increased the risk of culling 6–12 times during the first two months of lactation in the study of Rajala-Schultz and Gröhn (1999). For this and other reasons, such as its link with reduced fertility (Melendez et al., 2003), lameness results in substantial economic losses. For example, Dutch dairy farmers lose 4–5% of their income due to lameness according to Enting et al. (1997). For Czech dairy farms, no recent data on the prevalence of lameness have been published in the scientific literature, so the first aim of this study was to fill this gap and provide basic data on the current lameness frequency in a sample of 24 Czech dairy farms.

Most lame cows are not treated by a veterinarian (Murray et al., 1996), and therefore prevention is very important. One precondition for an effective prevention is the knowledge of risk factors associ-

Supported by the Ministry of Agriculture of the Czech Republic (Grants No. QD 0176 and MZE 0002701402).

ated with lameness (e.g. Hirst et al., 2002b). Some of the risk factors (Hirst et al., 2002a) are long-term and difficult to change, such as the genetic predispositions of certain animals and breeds to lameness or the necessity of indoor-housed cows to stand on hard and wet surfaces (Borderas et al., 2004). Other factors can be changed on the farm by improving management or housing on the farm. As the second aim of this study, we focused on some of these management-related risk factors. Specifically, we assessed the following hypotheses: Hypothesis 1. Suboptimal quality of housing, floors, and animal care could be assessed through a brief visit and this assessment could be used to predict the risk of lameness. Hypothesis 2. High body dirtiness and the presence of skin lesions indicate that cows have problems to cope with the stall environment and may therefore be connected with increased risk of lameness.

It is well known that overgrown claws increase the lameness risk (Manske et al., 2002a). Hoof trimming is applied either to the whole herd at predetermined intervals (for instance every 6 months) or continuously to animals identified to have the improper claw shape. The third aim of the study was to assess to what extent the proportion of cows with overgrown claws and the proportion of lame cows are affected by the trimming schedule, as reported by the farm managers. We expected that the shorter the time since the last trimming of the whole herd, the lower the prevalence of overgrown claws and lameness, and also that continuous trimming would have a reducing effect on the prevalence of overgrown claws and lameness (Hypothesis 3).

MATERIAL AND METHODS

Farms

Twenty-four dairy farms in Central Bohemia (within 90 km of Prague) were involved in this study. The herd size ranged between 72 and 860 (median 135) cows. Three of the farms had pure Holstein cattle, 18 had a hybrid population of Czech Pied (Simmental type) × Holstein cattle with prevailing Holstein genotype (the proportion of Holstein ranging from 64% to 99%) while on three farms the Czech Pied genotype prevailed (78%–86%). The grand average milk yield (average of farm means) was 7 485 ± 1 583 (s.d.) kg per standardized lactation. Nine farms were equipped with autotandem milking parlours, three with carousel parlours while twelve had a fishbone type of milking parlour. Cows were loose-housed indoors the whole year round on all farms. Twenty farms were equipped with individual lying boxes, while four had group pens with deep bedding for the lying of cows. Out of the 20 farms with individual lying boxes, 16 used straw bedding in the boxes, 3 were equipped with rubber mats and the remaining one had concrete flooring in the boxes covered with wood chips. Slatted floor in walkways was installed on 2 farms only, the other 22 had concrete flooring in the walkways and feeding area.

Data collection

Farm characteristics, cow performance data. Standard data describing the dairy herd (dairy cows' genotype, age, parity and milk yield) were collected from farm managers. We also asked the managers to describe the time schedule of hoof trimming: when the whole herd was trimmed for the last time, and whether they also trimmed individual cows with improper claw shapes outside the main trimming events ("continuous trimming").

Furthermore, an inspection was made on each farm by one of the authors (P.F.) during which the farm environment was scored subjectively on a 5-point scale ranging from 1 = excellent to 5 = very poor. The scoring took 45–60 minutes and was done separately from three aspects of the farm environment quality: (i) Floor slipperiness, judged by the presence of grooves, wet smooth inclined surfaces, slipperiness tested by walking on the floor, and observations of cows actually slipping. (ii) Cow care quality. This scoring assessed how much attention and care were devoted to the cows, judged from the following criteria: food quality, how food and bedding was provided, what proportion (subjectively assessed, no actual counting done) of cows was thin, lame or with overgrown claws, whether any signs of careful attention to problems, or on the other hand, of neglect or poor attitude to animals were noted. (iii) Housing quality, ascertained according to stocking density, dimensions of cubicles, amount and quality of bedding, light conditions. The purpose of this subjective scoring was to investigate whether such a simple system could be used to quickly assess the risk factors for lameness during brief farm visits.

Lameness and its diagnostics. Lameness was identified when the cows were walking from milking parlour. All milked cows in the herd were scanned and the identification number of any lame cow was noted. For the purpose of this study, "lameness" was defined as any degree of limping on one or more legs, ranging from slightly putting off weight from one leg up to walking on three legs only.

Claw status, skin lesions and body cleanliness. Claw form status, skin lesions and body cleanliness were recorded on 40 randomly selected cows on each farm. Between the milkings, the pre-selected cows were located one-by-one in the stable and the three variables were recorded.

The form of the claws was recorded as a binary variable. When all claws of the cow had a normal form, the status = OK was noted, whereas when at least one claw was overgrown or deformed, the status = overgrown was recorded.

The following types of skin lesions were noted during the examination: wound, scar, bald spot, scab, swelling, skin infection. For the purpose of this study, the records were later summarized into a binary variable of either no skin lesions detected on the animal or at least one skin lesion.

Body dirtiness was examined on five regions of the rear part of the cow's body: ano-genital region, udder seen from behind, hind underbelly and udder lateral view, thigh, hind legs below thigh. For each of the regions, a score of soiling was made on a 5-step scale graded by 0.5 from 0 = clean to 2 = very dirty (100% of the region covered with thick layer). The scores for all the regions were then averaged, resulting in one dirtiness index per animal.

Statistical analysis

Prevalence of lameness on each farm was expressed as the proportion of cows being at least moderately lame.

Risk factors of lameness at farm level. At the farm level, the following 8 factors were considered as candidates for influencing the prevalence of lameness: floor slipperiness, cow care quality, housing quality as evaluated by the subjective scoring of farm; the proportion of cows (out of the 40 ones evaluated per farm) with at least one skin lesion; the proportion of cows (out of 40) with overgrown claws; average body dirtiness; the average proportion of Holstein genotype within the herd and average milk yield of 40 sampled cows.

In order to check the strength of association of individual explanatory factors with lameness prevalence, Spearman correlations between the proportion of lame cows on each farm and the 8 factors were calculated. We decided not to analyse the influence of all the factors in one model (e.g. through multiple regression) because the number of farms with complete data for all variables (n = 18) was too low in proportion to the number of examined factors.

Hoof trimming schedules and their effect on overgrown hoofs and lameness. Using the Mann-Whitney non-parametric two sample test and Spearman correlations, we assessed whether the continuous type of hoof care and the number of months since the last hoof trimming of the whole herd affected the proportion of cows with overgrown claws and the prevalence of lameness.

Probability of being lame at the individual level. Repeated measures logistic regression with farm as the subject factor (PROC GENMOD of SAS) was used to investigate how the probability of being lame was related to the following factors: pure Holstein genotype; age (in years); days-in-milk (days since the last parturition); having at least 1 skin lesion; overgrown claws; and body dirtiness. The genotype, skin lesions and claw form variables were binary (0 or 1), whereas age, days-in-milk and dirtiness variables were continuous. Age and days-in-milk were taken as both linear and quadratic effects. Compound symmetry covariance structure was assumed within blocks (farms) and Type 3 analysis was used to calculate statistical significance. The analysis started with a full model of 8 factors and proceeded by excluding always the least significant factor (Backward Selection) until all remaining factors were significant at $P < 0.10$.

RESULTS

Due to technical reasons (denial of some farm managers to allow full data collection, unreliability of records due to unexpected disturbance on the farm) not all the categories of data were obtained on each farm. Hence, the number of farms entering the analyses differred from test to test.

Prevalence of lameness

The recorded prevalence of lameness varied between 6% and 42% of the examined cows on the individual farms (Figure 1), with first quartile, median and third quartile being at 15%, 22% and 29%.

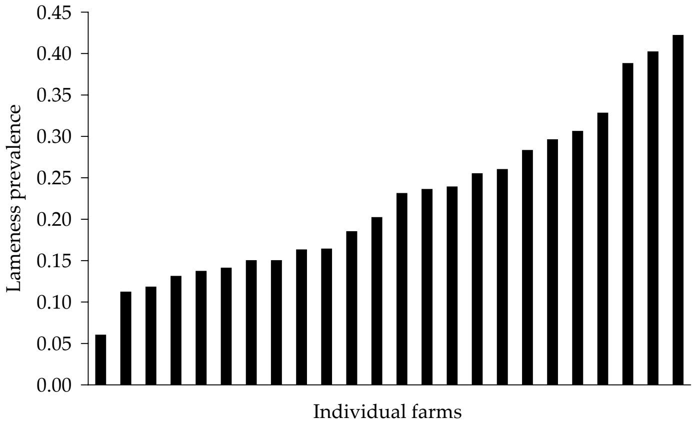

Figure 1. Lameness prevalence om the 24 examined farms

Factors related to the prevalence of lameness at the farm level

The Spearman correlations with lameness prevalence were significant for the factors cow care quality (r_s = 0.51, n = 21, P < 0.05, Figure 2), floor slipperiness (r_s = 0.48, n = 21, P < 0.05, Figure 3), and marginally significant for the proportion of cows with overgrown claws (r_s = 0.45, n = 18, P < 0.1, Figure 4). None of the remaining 5 factors, including the score for housing quality, affected the lameness prevalence significantly.

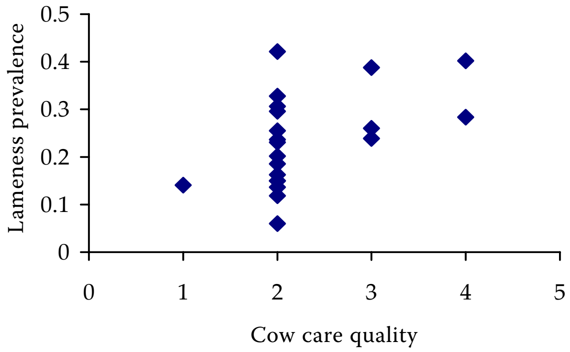

Figure 2. The relationship of cow care quality to lameness prevalence (n = 21 farms)

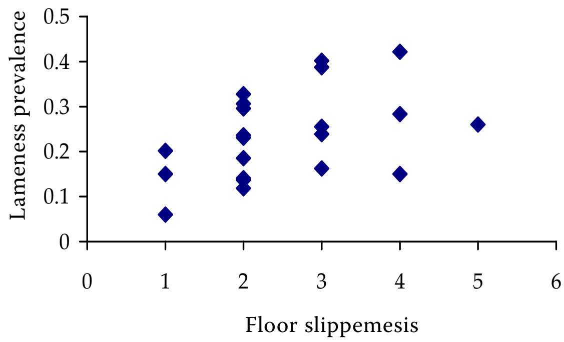

Figure 3. The relationship of floor slipperiness to lameness prevalence (n = 21 farms)

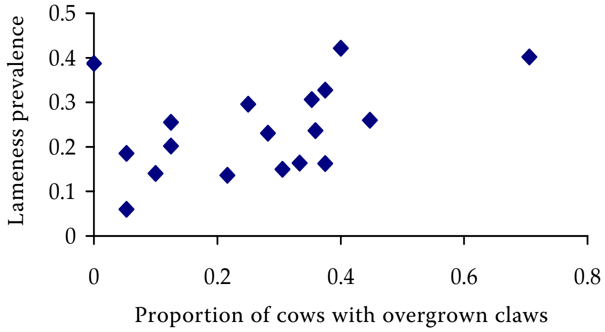

Figure 4. The relationship of the proportion of cows with overgrown claws to lameness prevalence (n = 18 farms)

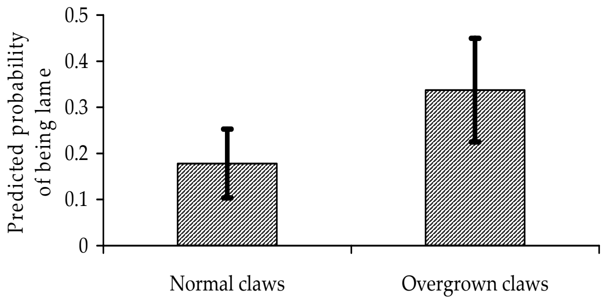

Figure 5. The probability of being lame in cows with normal and overgrown claws (n = 720 cows, i.e. 40 cows per 18 farms, means ± s.d.)

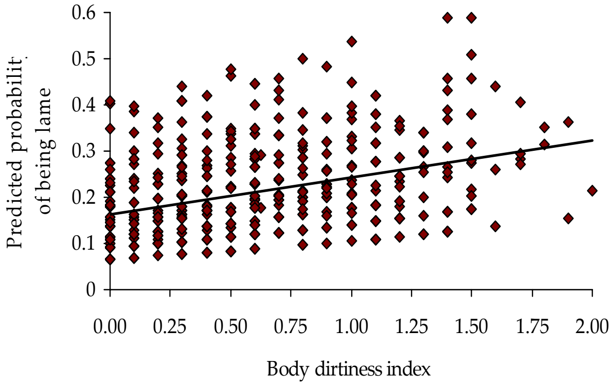

Figure 6. The relationship of cow body dirtiness index to the probability of being lame (n = 880 cows)

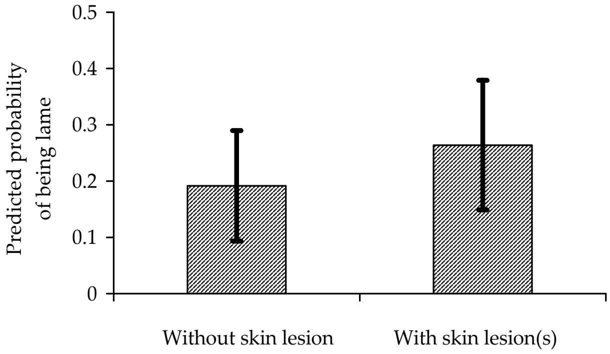

Figure 7. The predicted probability of being lame in cows with and without skin lesions (n = 880 cows, i.e. 40 cows per 22 farms, means ± s.d.)

The effect of hoof trimming schedules on overgrown hoofs and lameness

According to the reports of the managers, 11 out of the 24 farms used whole-herd trimming at regular intervals, 7 herds were trimmed continuously but not at regular intervals, and on 6 farms both regular trimming of the whole herd and continuous trimming were applied. On 2 farms with regular trimming, the trimming was in progress during the data collection and on 1 farm, the exact time period since the last trimming could not be determined with certainty. On the remaining 14 farms, the minimum, median and maximum number of months since trimming was 0, 4, and 10.

Neither the proportion of cows with overgrown claws nor the proportion of lame cows differed between farms that used and those that did not use continuous trimming (Mann-Whitney U-test: Z = 0.66, n_1 = 9, n_2 = 9, N.S. for overgrown claws and Z = 0.58, n_1 = 13, n_2 = 11, N.S. for lameness prevalence). The number of months that had elapsed since the last trimming of the whole herd did not influence the proportion of cows with overgrown claws (r_s = 0.11, n = 9, N.S.) or the proportion of lame cows (r_s = –0.45, n = 14, N.S.).

Factors related to the probability of lameness at the individual level

Of the 8 explanatory factors in the full logistic regression model, three factors (pure Holstein genotype, days-in-milk and days-in-milk squared) were dropped because they failed to show a significant relationship (P > 0.1) with the probability of being lame. Thus the final model contained five factors. Cows with overgrown claws were much more likely to be lame (logistic regression, P < 0.01, Figure 5). Dirty cows also had an increased probability of being lame (P < 0.05, Figure 6). The probability of lameness tended to be higher in cows with at least one skin lesion (P < 0.10, Figure 7). Finally, the probability of lameness was dependent on both the linear (P < 0.05) and the quadratic (P < 0.10) term of age (Figure 8) with cows in their 7th–8th year of life being at the highest risk of becoming lame.

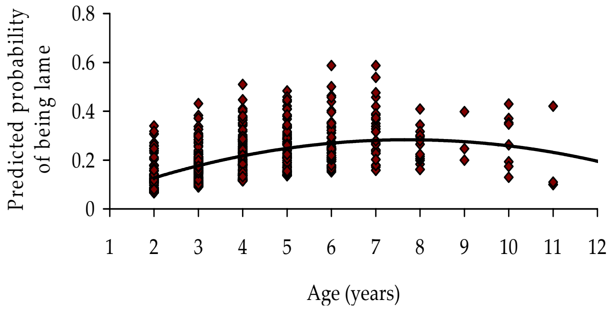

Figure 8. The relationship of cow age to the probability of being lame (n = 960 cows)

DISCUSSION

The prevalence of lameness in this study (22%) was higher than in some published studies (e.g. Alban, 1995: 7% in Denmark; Manske et al., 2002b: 5% in Sweden) but comparable to the prevalence reported in England a decade ago (Clarkson et al., 1996: 21%). However, the differences in the reported prevalence may be due to the different definitions of lameness because border cases of "uneven gait" or "imperfect locomotion" may or may not be considered as lameness by different authors (Green et al., 2002). More importantly, the studies agree that within one and the same country, the between-farm differences in prevalence are substantial (e.g. 2–54%, Clarkson et al., 1996; 6–42%, this study). Therefore, there is certainly space for large improvements for farms with high lameness prevalence. These farms should be motivated by the number of lame cows for two reasons: first, lameness is the third most costly disease for dairy farmers (after mastitis and fertility problems, Enting et al., 1997) and therefore a substantial increase in net income is to be expected if the lameness frequency diminishes. Second, farmers should be concerned ethically if such a large number of animals in their care are in a painful condition (Whay et al., 1998).

At the farm level, prevalence of lameness was most clearly related to floor slipperiness and cow care quality. These two factors showed significant correlations with lameness prevalence. Our first hypothesis was thus clearly supported.

Floor slipperiness was positively related to lameness prevalence. Poor quality of standing and walking surfaces has been beyond any doubt proven to be a major risk factor for lameness (Ward, 2001). Wet slurry on concrete floors was considered to worsen lameness because it softens the claw horn (Borderas et al., 2004) and exposes the feet to infection. Slipperiness of smooth floors was also suspected (Faull et al., 1996), but the objective measurements of friction coefficients started only recently (Telezhenko and Bergsten, 2005; van der Tol et al., 2005). It is encouraging to see that in our study, the relationship was moderately strong (r_s = 0.48) in spite of the fact that floor slipperiness was assessed very roughly through a subjective 5-point scale judgement. Hence, the results show that even a brief assessment of floor slipperiness by an experienced person can identify one of the leading causes of lameness on some farms. It is worth noting that the other aspects of housing, summarized in the scoring of housing quality, did not affect the lameness prevalence. From the practical point of view, this study brings evidence that reducing floor slipperiness may be one of the most efficient preventive measures to reduce the prevalence of lameness.

The other risk factor for high lameness prevalence was poor animal care. The scoring of this variable was based on a combination of multiple criteria and thus represented an overall impression of how much attention and care were paid to the health and welfare of the cows. Most of the farms scored 2, just one was excellent (score 1) and five farms attained score 3 or 4. It seems therefore that this type of scoring could be useful for identifying (the relatively scarce) farms with suboptimal animal care rather than for capturing fine differences between farms with the generally sound care of animals.

Another obvious risk factor for lameness is neglected or improper hoof care (Manske et al., 2002a). This was partially confirmed at the farm level in our study: farms with a high proportion of cows with overgrown claws tended to have more lame cows, according to the correlational evidence. This factor was even more strongly influential within farms, at the level of individual cows (see below).

An interesting result of our study is the absence of relationships between the time schedule of hoof trimming (whether continuous trimming was applied or not; and how much time elapsed since the last trimming of the whole herd) and the proportion of cows with overgrown claws or the proportion of lame cows. There may be two reasons why our Hypothesis 3 was not supported. Firstly, very frequent trimming does not necessarily mean better claw health and reduced lameness. Lameness may in fact increase immediately after trimming (Vermunt, 1999) and a trimming interval of 4 months or less may be associated with poorer hoof health than a longer interval (Huang et al., 1995). Perhaps an optimal trimming interval is about 6 months (Manske et al., 2002a). Secondly, reports by the managers cannot capture the quality of the trimming procedure which is at least as important as the frequency of trimming itself.

At the level of individual cows, overgrown claws were clearly increasing the risk of lameness. This result corresponds with a number of studies that documented an association between the improper claw shape and lameness risk (Manson and Leaver, 1989; Manske et al., 2002a).

The probability of being lame was increasing as the integument of the cow was more soiled with excreta. It is not clear what causal link or links may underlie this relationship. First, cows with more soiled body probably also have more soiled claws and this predisposes them to infections on the digits (Manske, 2002). Alternatively, lame cows may be less willing to find a proper resting place and/or to compete for it and therefore get dirtier through lying in soiled places. This explanation would be in line with the current finding that lame cows have shorter avoidance distances in an encounter with an unknown human person (Špinka et al., 2005), probably because they are less willing to move.

Lameness in our study was also related to the occurrence of skin lesions. It is unlikely that a skin lesion itself would increase the probability of lameness; rather, lame cows may be more susceptible to get injured and/or there may be a common causal factor behind both phenomena, such as impaired immunity or low social status of particular cows (Galindo et al., 2000).

Whatever the causal links, this study indicates a relationship between lameness, body soiling and integument lesions in individual cows, in agreement with our second hypothesis. Hence, a recommendation could be given to farmers to pay attention to individual cows with any of the three problems, as this could be the way to identify cows which are not generally coping well in the herd.

Age was another predictor of lameness. The lameness risk was increasing up to the age of eight years, with cows at this age being approximately twice as susceptible as two years old cows (Manske, 2002). Although it might be difficult to employ this knowledge directly in preventive measures for decreasing lameness prevalence, it is useful information for future studies on cow longevity and its economic and welfare consequences (Stott et al., 2005). The lameness probability declined among cows 8 years old and older, possibly because cows susceptible to lameness were selected out of the herds during earlier lactations.

The risk of lameness was basically flat across all stages of lactation in this study. Although sole disorders were reported to be most frequent 2 to 4 months after calving (Vaarst et al., 1998), clinical lameness was found independent of lactating stage by Hirst et al. (2002c) as well as in this study. Trying to prevent lameness and identify it early is therefore important for cows at all stages of lactation.

CONCLUSIONS

We conclude that:

1. There are large differences in lameness prevalence between Czech dairy farms.

2. Floor slipperiness and improper animal care are major factors predisposing Czech farms to high prevalence of lameness. These risk factors could be detected by a simple on-farm assessment system using subjective scoring system.

3. Within a farm, cows with overgrown claws, dirty cows and cows with skin lesions are at an increased risk of being lame.

Acknowledgements

We are grateful to all farm owners, farm managers and stockpersons for their cooperation in the project. We thank Robert Kněz, Marie Ticháčková, Kristýna Bělská and Renata Kolovratová for their most valuable help with the data collection.

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Received: 2004–10–20
Accepted after corrections: 2005–11–12

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