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Early detection of lameness in dairy cows with electronic activity sensors

Lameness can be classified visually. But this requires time and experience, especially in large herds. An electronic device for early recognition of lameness is desirable for veterinary and management reasons. The ALT-pedometer (ALT = Activity, Lying behaviour and (outer) Temperature; pedometer = step counter) is a proven animal recording system for determining movement activity. So far, it is mostly used for oestrus detection. This article concerns itself with the question to what extent ALT-pedometers can also help in detecting lameness. The presented first results are methodological preliminary investigations for a doctorate on early identification of lameness through electronic activity measurement.

Keywords
Lameness, animal activity, pedometer

Abstract
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Lameness is one of the most important herd problems in modern dairy cow management and represents – after fertility problems and udder disease – the third highest reason for culling [1]. It has a negative influence on economic performance and animal welfare. Mostly, lameness identification is very poor and its recognition too late, whereby treatment takes a long time and is expensive.

Traditionally, the locomotion score method represents a subjective possibility for assessing lameness in a herd. However, this approach lacks clear identification standards and relies on the skill of the observer in recognising subtle locomotion anomalies. Furthermore, dairy herds are increasingly larger and consequently farmers have less time for cow observation. This is why modern techniques for recognising lameness are used, one of which concerns the ALT-pedometer. First experiences with this pedometer technique have so far been concerned with heat detection [2]. In this investigation the ALT-pedometer is used for the first time in the early recognition of lameness in the dairy cow barn (**figure 1**). Four parameters were measured for this: activity, lying time, number and length of lying periods between the maximum and minimum value. The results should contribute to a doctorate project in progress on early recognition of leg and foot problems in dairy cows through electronic measurement of activity.

The work so far has led to the following hypotheses: With the help of ALT-pedometers a pattern of locomotor activity and lying behaviour of every single animal within a defined period can be recorded. Reductions in activity can be an indication of the beginnings of lameness. It is also assumed that lameness can lead to longer lying periods. Hereby it is important to take account of individual behaviour in that activity can differ substantially between animals.

Method

The experiments were conducted at "Frankenforst" research station, University of Bonn with 60 lactating dairy cows in a cubicle house of around 48 m by 17 m including water, forage and concentrate dispensers and with a 2 x 4 tandem parlour set-up for scientific investigations. Animal: feeding place and animal: cubicle ratios were 2:1 and 1:1 respectively.

ALT-pedometers were used to determine movement activity. These were developed, together with associated software and telemetric data transfer, by the engineering company Holz in Falkenhagen. The data recorded represented locomotor activity (steps) and lying behaviour determined. Via two further digital positional sensors in the pedometers it was whether the animal was lying and, if so, in which position: in a side position or on the breast.

Fig. 1

Activity measurement (ALT-pedometer). Photos: Alsaaod

The information was documented in four separate recording locations. The first contained only step movement details; the second the number of time units in the side lying position (11) and the third the time units in breast lying position (12). Calculation of the recorded time units gave the lying times in the different positions. One time unit represented 15 seconds so that with a lying cow four time units per minute were counted and recorded by the pedometer. Calculation of the signals in minutes was realized according to equation 1:

$$\text{laying time [min]} = \frac{\text{total laying signals} \cdot 15}{60} \qquad \text{(eq. 1)}$$

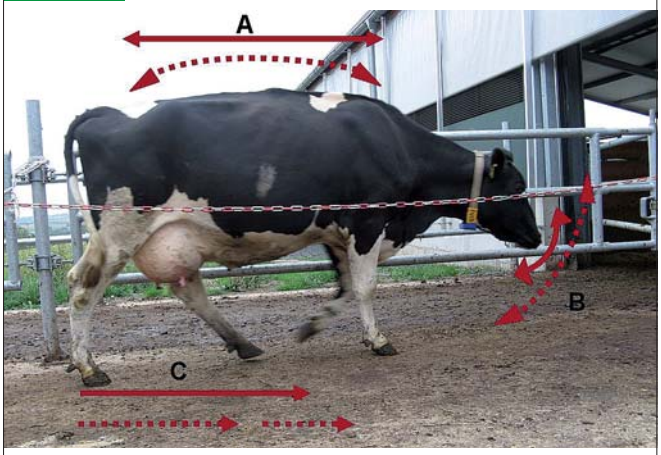
The lying times for the side position were determined in the same way. The μ-processor permitted the configuration of a measurement interval of 1–99 minutes. Within the experiment time all pedometers were set to a 15-minute interval so that the total of leg movements and the total of time units for lying positions were recorded in 15 minute time periods, as well as the time details (date, time) being recorded. A further recording location contained data on ambient temperature. However, these data were not taken into account in this investigation. Data were stored in a databank (MS Access) for subsequent individual processing.

Gait assessment

Immediately prior to attachment of an ALT-pedometer, the cow's gait was assessed according to the Flower and Weary method [3]. This represents a five-step assessment system to determine lameness with a notation of 1 (= healthy) to 5 (= very lame). For a precise result it is important that the cow is observed moving on straight and level concreted surfaces and is not being driven. For this reason the cows were observed on leaving the milking parlour on their way to feeding in the cubicle barn along a 16 m stretch. At this time animals also have uniformly empty udders. In other conditions these could influence gait. A part of the distance was reduced to a breadth of 1.15 m which forced the cows to move single in a straight line, allowing them to be individually assessed. The animals were always observed from an exactly determined distance from the side and behind. During the observation the arch of the back (standing and moving) and the bobbing motion of the head were first of all noted. In movement, notice was also taken of a shortening of the step with one or more legs (**figure 2**). Healthy animals were those that, one month before the start of observations, were found to have no leg and foot problems and scored movement points of ≤ 2. Animals with a point total of 3 or higher were classified as lame and not included. All cows with indication of heat, mastitis or other clinical systemic disease were also left out of the experiment. An important aid here was a recording form onto which herd data and descriptions of lameness and their causes could be entered.

In the investigation presented here, the lying behaviour and locomotor activities of 12 cows were recorded long-term via ALT-pedometers. The animals were assessed according to their gait (locomotion score). Special attention was paid to animals with a gait score of ≤ 2. With those, the aim was to calculate if and how alterations in activity could be used as indicators of impending lameness.

Fig. 2



A. Gekrümmte Rückenlinie/back arch
B. Wippen des Kopfes/head bob
C. Tracking-up/overlap (Δl)

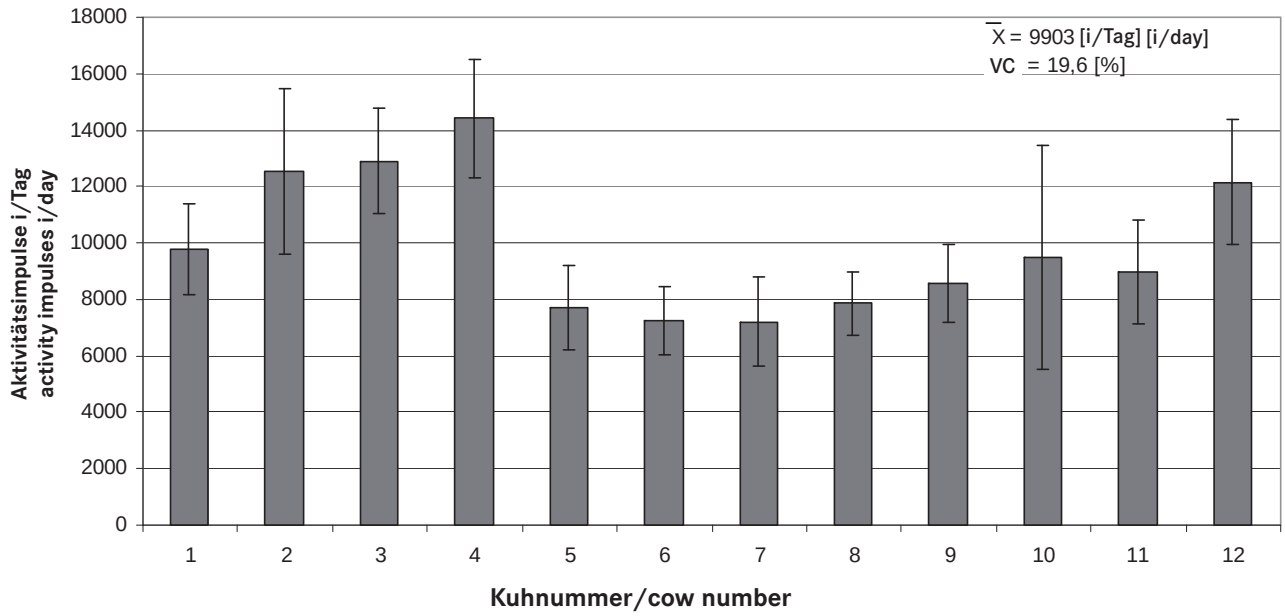
Gait assessment in dairy cows (locomotion score) (according to Flower and Weary [3])

Conclusions

First results of the investigation show that the recording of activity and/or lying behaviour via ALT-pedometer is possible and that the method can help for earlier identification of lameness in dairy herds. This research should represent a contribution encouraging introduction of an electronic "tool" in larger herds for lameness identification.

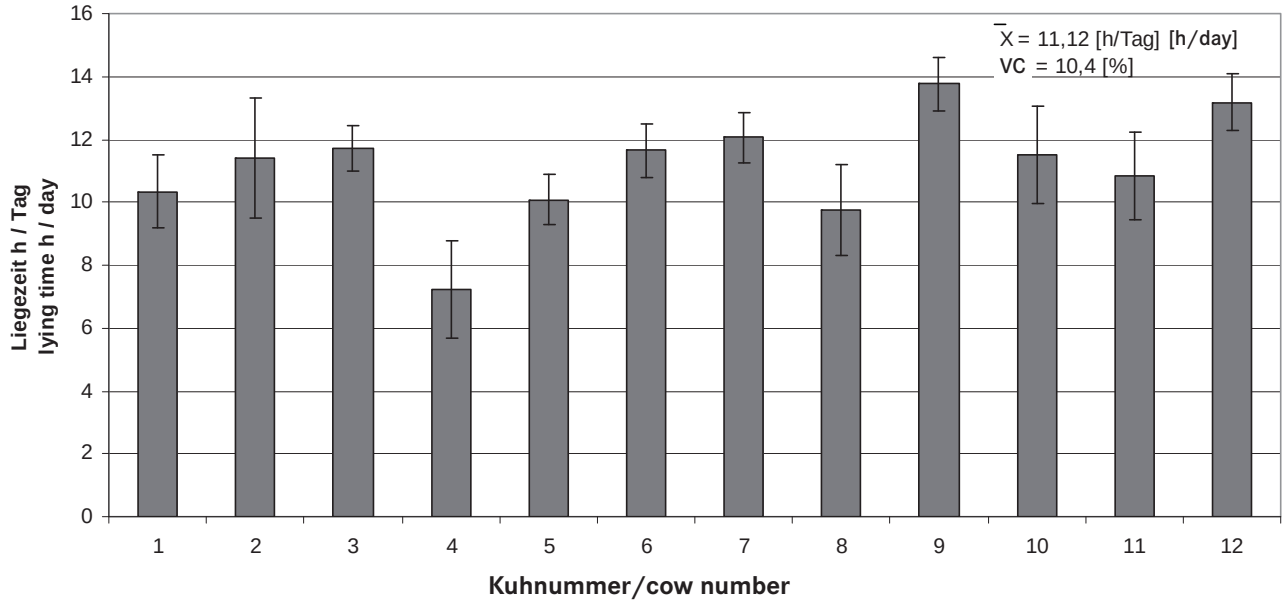
Observing the results of the 12 animals investigated so far according to the characteristics "daily activity" and "daily lying time" (**figures 3 and 4**) it was clear that a large scatter existed between animals. In other words, there was marked individuality. Consequently the characteristic sequences (**figure 5**) must be applied only to individual animals and not to the whole group. **Figure 5** shows the pattern of reducing activity over several days to visible problems on 17.10.2009 and the continually increasing lying time. At this point the daily assessment score for gait (locomotion score) changed from 2 to 3.

Fig. 3



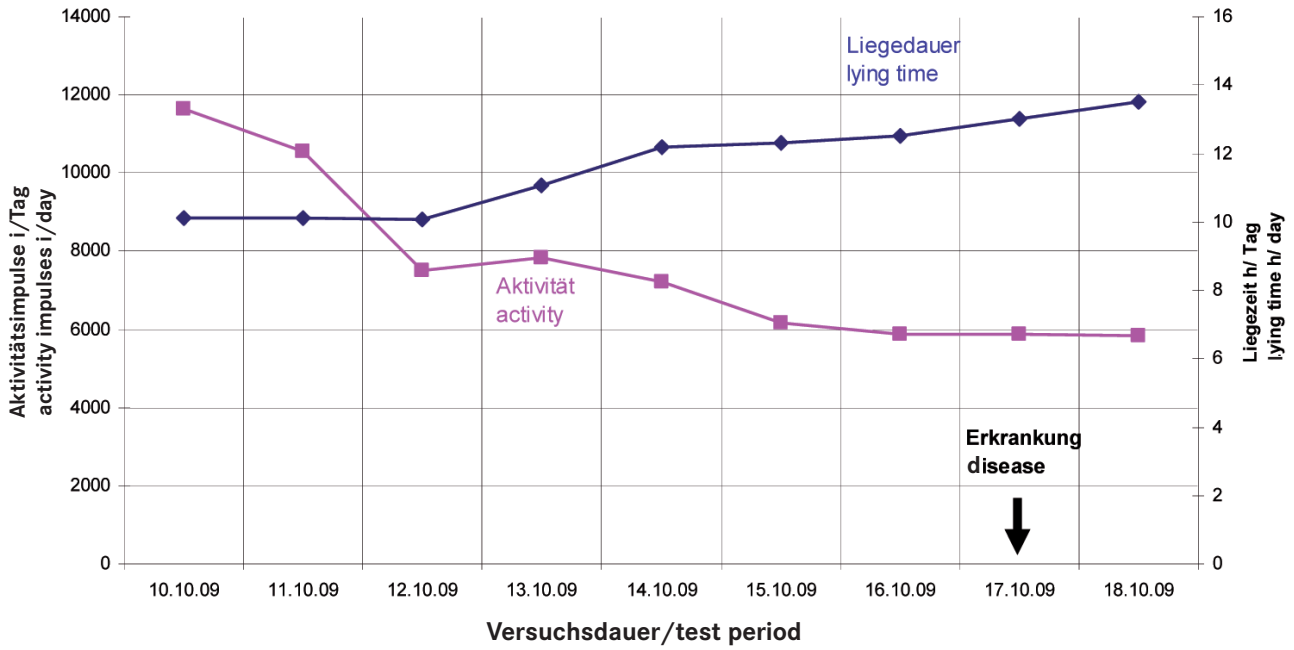
Mean number of activity impulses in i/day

Fig. 4



Mean lying time in h/day

Fig. 5



Mean number of activity impulses in i/day

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