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Oestrus Detection using ALT-pedometers under Field Conditions

Oestrus detection in high yielding dairy cows is becoming more and more problematic, according to latest studies. Manpower reductions and increasing mechanization reduce the time available for oestrus monitoring. Thus, electronic devices for measuring and detecting are key technologies for progressive automation in livestock husbandry. A new oestrus detection system based on ALT-pedometers was tested for ten months on a dairy farm in Brandenburg, prior to integrating it into a milking system producer's herd management system. Information about preliminary results is presented.

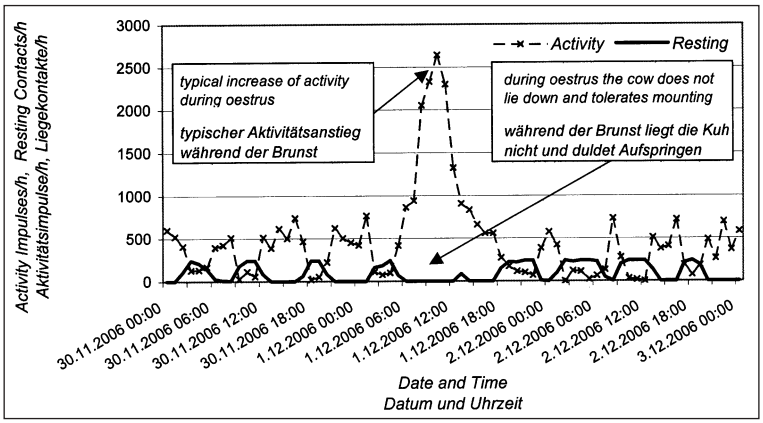

Fig. 1: Characteristics for typical oestrus, 21 d before successful insemination

Goal of a production scale experiment realized in a dairy farm in Brandenburg was to carry over a new sensor-based system for logging animal data for early detection of oestrus and diseases in dairy cows into industrial production.

150 cows in early lactation of the farm's total population of 430 were included in the experiment over a period of ten months. After calving the cows were outfitted with an ALT-pedometer before relocation into the group of cows in early lactation.

It was necessary to detect and document all occurring oestrus cycles up to the date of successfully diagnosed pregnancy. Evidence for a high oestrus detection rate of >90% throughout all cycles up to diagnosed pregnancy with the new data logging system should be provided.

Brandenburg top farm as base for the experiment

With an average milk yield of 10,530 kg per cow and year for the 430 dairy cows the farm chosen for the experiment is to be considered one of the top farms. Those high milk yields come at a price, though. Referring to [6], the reproductive life span of Saxon cows is about 54 months only, one third of all heifers don't calve for a second time and the rates for stillbirths in heifers are at about 15%. Fertility currently is a serious problem in dairy cow populations, especially in high milk yield areas of >10,000 kg per cow and year. Dutch and American studies [1, 5] show that high-performing cows cause problems in oestrus detection despite optimal supply of forage. It was noticeable that 30% of the Holstein cows tolerated mounting only for at most four hours. In consequence of this trend often only 50% of all oestrus are detected. The biologically reasoned, recurring cycles of oestrus are determined by certain characteristic traits. These traits have decisively changed with increasing yields during the last years, as is shown in *Table 1*.

These criteria show why problems in oestrus detection escalate more and more, and why cows showing a "silent oestrus" are identified by the staff only in small numbers or even not at all during the visual oestrus monitoring. Currently in the US only 41% of cows in heat are detected [2]. During our studies we found that more than 60% of the oestrus cycles occurred past 7 p.m., and thus in a calm period in the stable without any monitoring of animals. Considering today's state of production in the dairy cow sector this means: cows in heat for 6 to 8 hours are not detected as "in oestrus" by the staff next morning. This impressively emphasizes the need for a technical data logging system that, as a result of the data gathered at night, can provide an alarm list with cows potentially in oestrus next morning. This list still requires professional review and decisions by the herd manager, though.

Table 1: Oestrus parameters subject to on annual milk yield per cow

	≤ 8000 kg milk	≥ 10000 kg milk
oestrus cycle normal 21 days	18...28 days	
in heat normal 16...8 h	8...10 h	
mounting phase normal 6...8 h	4...6 h	

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Keywords
Dairy cow husbandry, pedometer, oestrus detection

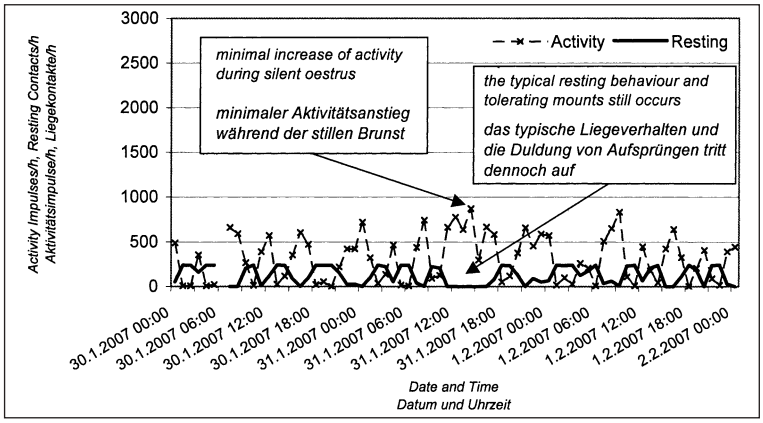

Fig. 2: Characteristics for silent oestrus, 24 d before successful insemination

The sexual hormones (pheromones) released during the oestrus cycle stimulate an amount of cows to do certain sexual activities (licking, mounting) which lead to increased activity for these as well, without being in oestrus themselves. To detect these "false positive" animals is a task for both the detection system and the herd manager by monitoring the cow data in the heat planner and visually surveying the cow as well.

Fuzzy Logic models for evaluation of the experiment

Detection rates for oestrus with ALT-pedometers currently are about 80%. To increase this value, it is necessary to include further relevant parameters. For evaluation of the data knowledge-based methods like Fuzzy Logic are used increasingly to safely detect oestrus and achieve an optimal insemination [3, 4, 7]. The registration of resting time by means of the ALT-pedometer in addition allows for detection of silent oestrus. The oestrus detection systems currently in use rely on an animal's activity increase as trait for oestrus detection. This at the same time implies that the cow in heat tolerates mounting and meanwhile lies down only for brief moments or, more often, not at all, which can be found in the curve for resting time in *Figure 1* quite well. Detection of silent oestrus by means of activity is impossible, though. The increase of activity in that case is either only minor or not given at all. Nevertheless the cow shows the typical toleration behaviour as described above (*Fig. 2*). False alerts are another problem with oestrus detection, which can be triggered by activity peaks not caused by oestrus. Those can be minimized using the resting time as well, as the toleration behaviour does not occur in this case (*Fig. 3*). False alerts can also be minimized by consistent use of the heat planner, but it is as a start necessary to detect the first oestrus to determine a time-frame for future oestrus cycles. Taking into account the time span for post-natal oestrus of about 12 to 17 days after calving as well as the possible periods for oestrus cycles in high-performing cows, the period required for monitoring is more than two weeks. These individual fluctuations are noticeable not only in the duration of the oestrus cycle, but activity level and resting behaviour differ as well, depending on the animal. A decision support method for oestrus detection thus needs to consider different data at the same time, combine them in a factually correct way and finally evaluate them with reliable results.

An algorithm based on Fuzzy Logic is able to evaluate combinations of several traits based on expert knowledge. Animal-specific differences in traits can be taken into account as well, as the data is assigned to colloquial variables that merge fluently. "Calculations" aren't done with crisp values, but instead for example "low", "normal" or "high" activity are used, and each value gets assigned memberships to these states accordingly ("still normal, yet slightly increased activity"). These states can be combined with each other in rule sentences. For instance a rule sentence could read: "If activity is very high and resting behaviour shows the toleration phase and according to lactation day oestrus can be expected, then oestrus is on hand." By means of Fuzzy Logic it is possible to account those verbalized conditions depending on degree of performance, thus translating human thinking in computer-compatible form. As results either strictly classified statements ("oestrus", "silent oestrus", "no oestrus") or degrees of performance from 0 to 1 for oestrus interpretable by the herd manager ("values above 0.85 imply oestrus") can be given.

Conclusion for the practice trial

The first preliminary results could be calculated for about 50 cows which could be successfully diagnosed as pregnant yet. In different variants detection rates between 72.1 and 82.8% could be realized, error rates were fluctuating between 39.0 and 62.5% still, though. By now only data for activity and resting behaviour was taken into account, though. In further steps the detection algorithm is now going to be improved. It is scheduled to include the heat planner data, which should lead to a decrease of the error rate especially. Also the remaining 100 cows will be included into the evaluation as soon as they are found to be in calf and thus the actual oestrus dates can be comprehended.

Literature

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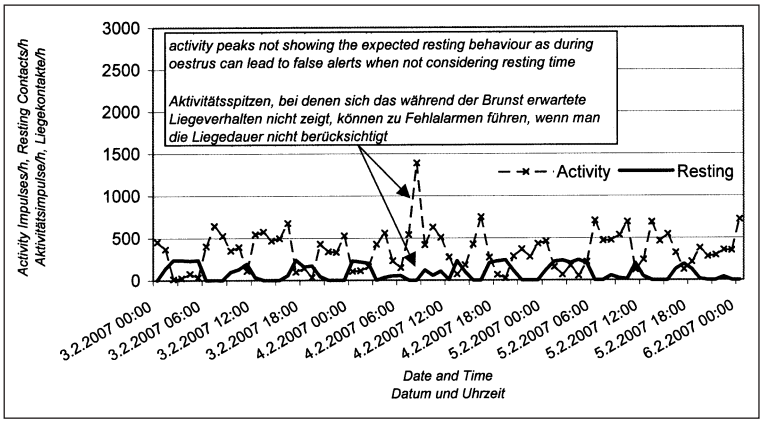

Fig. 3: Activity peak outside oestrus cycle, 36 d before successful insemination