ALT pedometer – a new sensor-aided measurement system for improvement in oestrus detection

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Abstract: Without sensor-aided animal data measuring systems far fewer oestrus cycles are recognized because cycle length, oestrus duration and oestrus intensity have developed negatively at high animal performance rates. This development makes it eminently clear that observation of the mating season in the dairy cattle sector is even more important than assumed so far if the financial losses due to insufficient herd fertility are not to become a business problem. Electronic identification and measuring systems represent key technologies for progressive automation in animal husbandry in modern, future-oriented livestock farming. Suitable objective measuring systems are needed in animals husbandry to quickly and safely recognize animal illness, normal oestrus cycle, silent heat or suffering from stress. Pedometer and transponder from different companies play an important role for measuring from animals data and statements in animals health and oestrus monitoring. Modern sensors (sensors, bio sensors), increasingly non-invasive measuring and transfer methods make crucial improvements in the potential for measuring animal data. A new type of pedometer, called ALT pedometer, for three measurement parameters (activity, lying time, temperature), a real time watch and a change measuring time interval was developed. With this system it is possible to select different time intervals between 1 and 60 min for continuous measuring. The results for oestrus detection are excellent. The high correspondence between the measuring parameters activity and lying time allow a statement to be made early and safely on animal illnesses and the time of the oestrus cycle.

Keywords: oestrus detection; pedometers; sensors; dairy cow

Economic efficiency in milk production is influenced from feeding, good health of the herd and high reproduction results from dairy cows. Not, or to late detected oestrus or illness from animals have a negative impact of milk and fertility results as well as serviceable life of the herd. For better herd management in dairy cows, measurement systems with pedometer or transponder for measuring animals activity are used by farmers. The gauges include the movement activity of the cow automatically and continuously. They are offered as for attachment either at the foot or at the collar or are integrated in the transponder. The arising impulses are counted, stored and questioned and transferred to the PC about reception units installed in the stable or in the milking stand. Fertilization time should lie in the second half of the mating season. Best conception results would be obtained within 12 to 20 h after beginning of the mating season. In the case of inaccurate details about the time of the mating season beginning it is move favourable to inseminate rather earlier than too late.

In a study conducted in 16 Brandenburg dairy farms with cow herds of > 290 animals, 75% of all farms showed losses in the dairy sector of between minus 199 and minus 672 €/cow due to an unsatisfactory fertility management (in inter-gestation period (ZTZ), in inter-calving period (ZKZ), in fertilization index (BI) and others) (Fröhlich & Platen 2002; Wangler & Meyer 2003).

An essential basis for good reproduction performances is exact mating season control. The conventional visual mating season observation takes much time and presupposes a high degree of experience. Reduced workers and lacking specialist staff are particularly factors in large-scale enterprises which stand contrary to efficient visual mating season control. 10 min were e.g. recognized (Heres & van Eerdenburg 1999) so after Dutch examinations on 32 farms at an observation duration of 2 times daily

in dependence of the time at only 8.6% to 25.7% of all cows in heat. The results of new studies from The Netherlands (Utrecht University) and the USA (Virginia Tech University, Blacksburg) show fluctuations in the cycle length, shorter oestrus intensity and short mating season duration in high-performing dairy cows. In the Dutch studies conducted with altogether 1500 dairy cows, the scientists found an oestrus duration of on average only 8 to 9 h, and in some cases of just 4.5 h (Anonym 2003). The researchers in Blacksburg obtained similar results with 2600 dairy cows. Here the average mating season duration of the Holstein cows was 7.3 h and of the Jersey cows 8.8 h. It was striking that 30% of the Holstein cows showed a toleration reflex for at most only 4 h. The fluctuations in the cycle length lay between 18 and 25 days (Nebel 2004).

As a consequence of this development often only 50% of the oestrus cycles are recognized, and even the best herd managers only "dicover" between two thirds and three quarters of all cows on heat. This develoment makes it eminently clear that observation of the mating season in the dairy cattle sector is even more important than assumed so far if the financial losses due to insufficient herd fertility are not to become a business problem. With the aim of reducing the required time for the visual mating season observation a number of technical aids was developed, like pedometer for measuring the movement activity of the cows (Liu & Spahr 1993; Arney *et al*. 1994; At-Taras & Spahr 2001; Brehme *et al.* 2004). An amplified restlessness and the resulting cow movement activity of the cow increased are essential symptoms of the mating season. The average raises of the activity at the time of the mating season from 30% to 393% are indicated in the literature (Kiddy 1977; Eradus *et al*. 1992; Wendl & Klindtworth 1997; Wangler & Schimke 2001; Kerbrat & Diesenhaus 2004). The mating season observation and the correct mating season reconnaissance substantially influence the reproduction performance of a herd. Nebel *et al*. (1997), De Mol (2001) and Laven (2004) describe several technical possibilities of the mating season reconnaissance as e.g. regular oestrus observation, regular milk progesterone measurement, heat-mount detectors, pedometers, electrical resistance and change from temperature in milk and body. The safest sign for an oestrus is the toleration reflex. The period of time is between first and last on-jump 7.1 h on an average. Becoming in this time on an average 8.5 on-jumps of about 4 s duration tolerated respectively. Influence factors, with an adversely influence of the intensity of the oestrus are slippery floor covering in loose barn, too little place for the mating season activity, seasonal temperature fluctuations and the time of day and the work in the stable (like animal medical activities, feeding, milk). After examinations and studies of Wangler and Schimke (2001), Brehme *et al*. (2004), Nebel (2004) up to 70% of milking cows fall in heat between 06:00 p.m. and 06:00 a.m. and respectively 07:00 p.m. and 07:00 a.m. To make the mating season reconnaissance easier, different technical aids were developed, different animal data were measured. Best results in oestrus detection years ago delivered pedometers they report the increased activity to animals in mating season (Maatje *et al*. 1997).

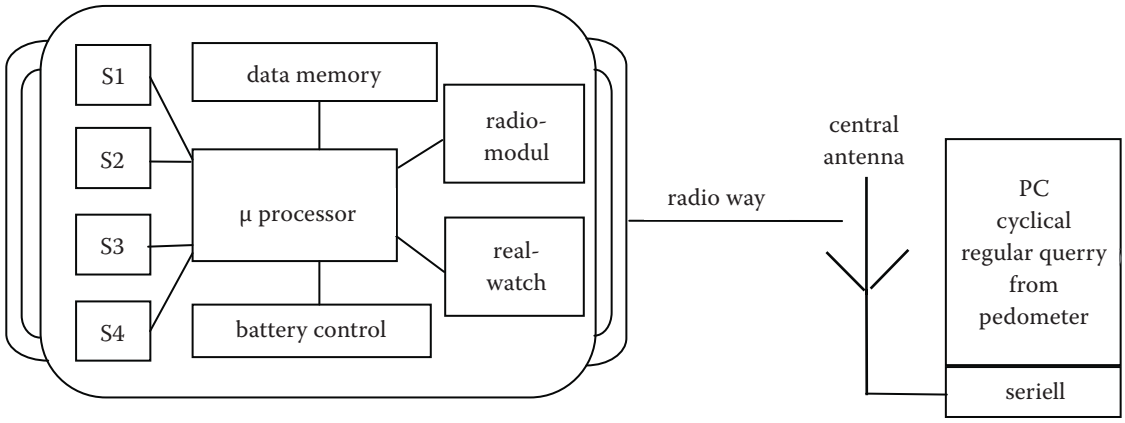
Electronic identification and measuring systems represent key technologies for progressive automation in animal husbandry in modern, future-oriented livestock farming. Suitable objective measuring systems are needed in animals husbandry to quickly and safely recognize animals that are ill, ready to mate, in silent heat or suffering from stress (Maatje *et al*. 1987).

In our examinations in to mating season reconnaissance the measuring parameters of animal activity and laying time showed the best results. Other parameters in our examinations did not show satisfactory results. This concerns the vaginal mucus conductivity and the body core temperature (Brehme *et al.* 2000; Brehme & Brunsch 2002). Both could be measured only with invasive measuring methods by a data logger inside the vagina and are disapproved by the animal conservationists. Measuring of milk temperature shows a high interest of "false positive" animals and the results are not usable. These problems with other physiological animal parameter are also confirmed by other authors (Gartland *et al*. 1976; Firk *et al*. 2002). The measuring of progesterone is very expensive and problematic in its precision (Moore & Spahr 1991; Eddy & Clark 1987; Nebel *et al*. 1987).

The objectives of this study were the improvement of detection rate of oestrus, finding weak or silent oestrus cycles and comparison from ALT pedometer with other systems. Previous works were studies with thermo-implants and vaginal data-logger for measuring body temperature, body core temperature and mucus conductivity for identification from oestrus. We also test the possibility to detect cows in heat with an infrared camera and higher temperature in labia area in oestrus cycle.

Construction and operation of ALT pedometers

The mode of operation of pedometers for the measuring parameter of animal activity works on the



S1–S4 = sensors for activity, lying time, temperature

Figure 1. Circuit diagram ALT pedometer (Brehme *et al.* 2004)

principle of pulse metering. Only the activity rate of the animal, which is counted as an electrical impulse, is of interest for statements concerning the animal health and the oestrus cycle. ALT pedometers are an animal data acquisition system developed further on the basis of standard commercial pedometers such as have been used for activity or step counting in the dairy cattle sector for approx. 30 years. ALT is an acronym for activity, lying time and temperature in the pedometer sector. These parameters are measured to detect oestrus and monitor animal health of dairy cows. The decisive advantages of this type of pedometer over the models used at present in cattle management lie in the following characteristics:

– Measuring of three animal-specific parameters (activity, ambient temperature at the pedometer, lying time), instead of one feature (activity). Selectable recording interval for recording all parameters in a measuring range of 1 to 60 min. Continuous acquisition of measured data, storage and manual or automatic data transmission to the PC by means of radio modem.
– The high correspondence between the measuring parameters of activity and lying time allow a statement to be made early and safely for animal illnesses and for the time of the oestrus cycle.

Figure 1 shows the structure of the ALT pedometer. The pedometer contains four sensors for recording the ambient temperature at the pedometer (S1), the lying positions (S2, S3), and the step activity (S4), the μ processor, the data memory, as well as the radio module for wireless data transmission.

As of this autumn a real-time clock will complete the measuring technology in the pedometer. The activity is measured using an analogue piezo-sensor, the lying time with digital position sensors, and a thermal sensor records the ambient temperature at the pedometer.

Two lying sensors were integrated since in addition to their normal lying position (belly position with legs folded beneath) cattle also rest in a side position. Under ethological aspects the "relaxed" form of cattle resting in the side position is of great interest for farmers in order to assess the well-being of the cattle and the suitability of the equipment technology for the lying box.

The pedometer is attached to the animal by means of plastic or belt webbing with a Velcro fastener at the pastern of a foreleg at the food. Only clearly activity rates are recorded here. Attention should be paid to the correct operating direction when the pedometer is affixed to the animal (marking in the case), since if the ALT pedometer is fitted wrongly the laying sensors for recording resting times cannot work.

Figure 2. ALPRO activity meter on the neck

The μ processor records the step activity and lying positions of the animal continuously and adds these together over the measuring interval configured at the start of the test (1 to 60 min). After expiry of the selected measuring time the value is stored in the memory unit.

The sum of the step activity, the lying time and the ambient temperature forms one data set. The memory capacity of the ALT pedometer is 1178 data sets, which are read out cyclically, optionally via manual or automatic (radio modem) operation (Brehme *et al*. 2004).

Description ALPRO management system

ALPRO is a totally integrated system for monitoring and controlling milk production on a dairy farm. Each hour, 24 hours a day, 365 days a year, it controls feeding, records milk yields, controls cow activity and gives you immediate access to very important information. This information provides help in finding any type of problem that can occur regarding milking, feeding, breeding and health. It can also be used for follow-up and long-term planning. All these together are essential parts in your strive towards improved and successful herd management (DeLaval 2001a). With ALPRO system, milk producers have total control over a herd of up to 2800 cows. The ALPRO system is built around a system processor connected to feeding stations, milking parlours, identification, cutter gates and so on. The ALPRO Windows programme has a mirror data base which makes it possible to disconnect the PC and work in the programme somewhere else. Daily milk yield recording is one of the most important decision aids for fine tuning the herd. It is possible to view the information either through the processor itself or through the MPC, which makes it easy to e.g. compare todays yield with yesterdays and the seven-day average in the parlour. If a cow milks less than expected (depending on the pre-set alarm level), this will automatically be indicated on the MPC in the parlour (DeLaval 2001b). Using ALPRO for reproductive management and breeding in combination from milking information and ALPRO activity meters:

– Identify cows in heat. Research shows that decline in morning milk might indicate oestrus.
– Cows with potential health problems early by using milk yield, feed intake, peak flow rate etc.

With the integration of milk recording and feeding, it is possible to compare this data with e.g. manually observed signs of number of daily readings in combination with a smart filter ensures that the farmer will get early information, which makes it possible to plan inseminations and separations well before a milking session (DeLaval 2001a) heat. A dairy cow that is in heat normally drops slightly in milk production and might reduce her feed intake. All this can easily be evaluated with the ALPRO system where you have all the information stored in the processor. The system uses a radio link to collect the activity information once a hour. This high number of daily readings in combination with a smart filter ensures that the farmer will get early information, which makes it possible to plan inseminations and separations well before a milking session (DeLaval 2001a). These benefits together will have a great impact on the dairy's calving interval and overall profitability. To get the best possible heat indications, the ALPRO system provides the herd manager with the following data (DeLaval 2001b):

– activity,
– expected heat date,
– individual feed consumption,
– individual milk yield development.

The system also produces an attention list containing valuable breeding information such as:

– cows due to be inseminated,
– cows expected to be in heat,
– cows to be checked for pregnancy,
– cows to be dried off,
– cows to be steamed up before calving,
– cows that are due to calve.

Figure 2 shows an example from an ALPRO activity meter on the neck.

MATERIAL AND METHODS

Since 1994 investigations were made in farms with suckling and dairy cows using sensor-aided neck transponders, thermo implants, data loggers and pedometers in order to develop a good measurement system for oestrus detection and animal health for safety concepts in production, herd management and economic efficiency of farms. In this time we worked together with colleagues from Bologna in bilateral research projects between Italy and Germany. As test animals we used in Germany and Italy suckling and dairy cows. The location of sensor implants, data logger and pedometer, also the types of antenna for data transmission were different in the stages of the tests from 1995 to 2000 (Brehme *et al*. 2000; Zappavigna *et al*. 2000). In order to evaluate the possibility of improving the performance of these systems, the behaviour of animals in the oestrus phase were analyzed using vaginal probes capable of detecting activity, mucus conductivity as well as

body core temperature data at first. The probes are made up of sensors connected to two variants of data logger capable of storing the data and downloading them periodically via radio modem on a computer. The probes were developed by Institute of Agricultural Engineering in Bornim e. V. and used in joint research investigations with various objectives.

The investigations have been carried out using a vaginal data logger with two sensors for recording at first the data combination body core temperature and mucus conductivity and at last the combination body core temperature and rate of movement activity. The data were collected in various phases at 1 to 15 min time intervals in different groups of suckling and dairy cows.

These loggers are integrated in the animal's body for a long time, to measure and collect animal data. For measuring vaginal mucus conductivity we fixed electrodes outside, at the loggers bottom. The logger is a water and shock – proof data collector – with a pressure resistance of up to 10 bar with a recording capacity of 33 000 data. The logger has two channels for data recording. The storage capacity for each parameter is 16 500 data. Time for measuring is from 4 to 454 days and one can program the logger for scanning intervals from 10 s to 20 min. Power for the logger is provided by a 3 volt Li-battery. For fixation in the vaginal tract we used a plastic spider at the end of the logger. Loggers of the 1st generation measure the parameters body core temperature and mucus conductivity. A great disadvantage of the 1st data logger generation was, that direct data transfer from the animals body to the PC was not possible. Only at the end of an investigation, the collected data could be transferred to the PC. In 2nd logger generation the measurement of mucus conductivity was substituted by the measurement of activity, while the measurement of body core temperature was retained. All loggers have been equipped with a better shock sensor for the exact measurement of animal activity. The direct transfer of the collected data from the animals body via modem to the notebook or laptop was realized in the 2nd generation of the logger in 1998.

Body core temperature and movement activity are important physiological parameters for animal health and oestrus cycle with cattle. These are central criterions for monitoring animal health and gives important information for oestrus detection and birth. A significant influence on the level and the course of body temperature have housing systems, environmental conditions such as climate, humidity, precipitation and air movement, age, oestrus and birth, activity or feeding. All these factors lead to variations in the course of body temperature of cattle (Artmann 1998; Auernhammer 1995). In search for a system for oestrus detection and animal health for cattle, which works continuously and accurately, the development went from an invasive systems with implants and vaginal data logger to a non-invasive measurement systems with pedometers or neck transponders, because the lobby of animal conservationists is against this form of animal investigations in Germany.

The development for a new type of pedometer was started in 1999 after tests of the daily biorhythm from dairy cows. We recognized the important role of the parameter "lying time" in the oestrus cycle of cattle and so we decided that the new type of pedometer must be an aided sensor system for measuring activity, lying time. The decision for a thermo sensor too, it was a selection by our cooperation partners from industry. They argue that the outdoor temperature on animals ankles is a good reference for animal welfare when the laying box will be value for good animal conditions in dairy farms. After completion of the various stages of development of the measuring system practical tests were carried out using 6 to 10 ALT pedometers on five dairy cattle farms in the last years. The aim of these test series was to examine the operational reliability of the system for data acquisition and for data transmission, and the usefulness of the readings for the oestrus cycle prediction in concrete farming business.

For the check of the efficiency of the new measuring system a line comparison was carried out with a milk livestock by 600 cows in a test enterprise between the ALPRO activity meter and the ALT pedometer system.

Aim of the comparison was examining it as exact, reliable and the two systems comprehensively register an incipient oestrus or an incipient animal illness.

The test started with 10 experimental animals in February 2004 and ended after seven months in August 2004 with the same number of laboratory animals. All experimental animals became after successful calve adopt in the investigation on February 1st. The period for calving for the cows in the investigation was February 1st ± five days. The prerequisit insisted that at least 3 to 4 oestrus cycles will appear in all experimental animals over a test time of 7 months. Our aim it was we must recognize these oestrus cycles exactly and early after approx. 80 to 90 days in lactation before the cow becomes an insemination. All experimental animals were equipped with an ALT pedometer at the left forefoot and an activity meter in the neck of DeLaval at the test beginning in February 1st. All animal data were

reprocessed after a cyclical query in the PC. The results of the two systems were checked and compared with visual oestrus control on the stable staff and the current oestrus calendar. The pedometer data were transferred cyclically in the regular of 4 h. The data of the activity meter of the ALPRO system were taken twice daily in the milking stand. The animal data in the ALT pedometer system were recorded and filed continuously in a measuring time interval of 5 min. By the use of a real time watch a complete and exact data set assignment was ensured. The usual farm measures for oestrus cycle monitoring were being continued and recorded to allow a comparison between visual oestrus cycle observation by the farm staff (milker, insemination technician, stockbreeding manager and others), and other automatic animal data acquisition systems.

The operational efficiency and stability of the data measuring for the criteria:

– continuous, complete and exact parameter recording,
– data storage, automatic transmission to the PC,
– incorporation into the animal file and graphic display of results has already been tested successfully.

Combing the parameters activity and lying time permits safe determination of the optimal oestrus climax exactly and as early as possible. Results of the comparison are introducted.

RESULTS

It is evident in all investigations that the ALT pedometer recognizes substantially more oestrus cycles. The proportion of cycles additionally registered lies between 25 and 61%. In a direct comparison with the ALPRO activity meter was ascertained that the ALT pedometers report the incipient oestrus one day earlier and show the exact time of oestrus beginning. This is due to the shorter cyclical selection interval of the ALT pedometer. The problem of absence of better results from ALPRO system in the comparison was that the data of the activity meter were taken only twice daily in the milking stand.

The ALT pedometer will carry out a data transmission considerably more frequently i.e. within a 4 h cycle or 6 times a day giving a better and more detailed information about the animals to the farmer. An oestrus climax can be recognized by it more exactly and faster through the integrated real watch in ALT pedometer. Changes are also transmitted fast and for certain to the activity with that within the night hours. Table 1 shows the results of both systems and the visual monitoring of the stable staff in the test period.

As a result it becomes clear that more and more accurate insemination measures can be carried out with sensor-supported data measuring systems. A comparison of the registered oestrus cycles shows this between the technical systems, ALPRO and ALT pedometer, and the visual oestrus monitoring by the stable staff in the test time period. The ALPRO system recognized 23 and the ALT pedometer 40 oestrus cycles. By the visual oestrus monitoring of the stable staff only 17 oestrus cycles could be registered. But we can also ascertain, the ALT pedometer measuring system with two measuring parameters (activity and lying time) registered in the direct comparison with the system ALPRO with only one measuring parameter (activity) 57.5% more oestrus cycles in the same period under the same attempt terms. In particular the recognition of "quiet oestrus" proves to be a key area of on-farm visual oestrus monitoring. Our

Table 1. Results in oestrus detection between the sensor-aided systems from activity meter of ALPRO, from ALT pedometer and the visual monitoring form stable staff (Brehme *et al.* 2004)

Animal number	Pedometer number	ALPRO system	ALT pedometer	Observations from stable staff
426786	P1	3*	3	2. cycle recognized
829575	P2	no signal	3	no cycle recognized
426610	P3	no signal	6	1. and 2. cycle recognized
852740	P4	2*	3	all cycles recognized
829554	P5	3*	4	2. cycle recognized
829502	P6	4*	4	all cycles recognized
829543	P7	4*	6	1. cycle recognized
852846	P8	2*	2	2. cycle recognized
829530	P10	3*	5	1. cycle recognized
829564	P11	2*	4	1., 2. and 3. cycle recognized

*all oestrus cycles by ALPRO system were detected always one day later!

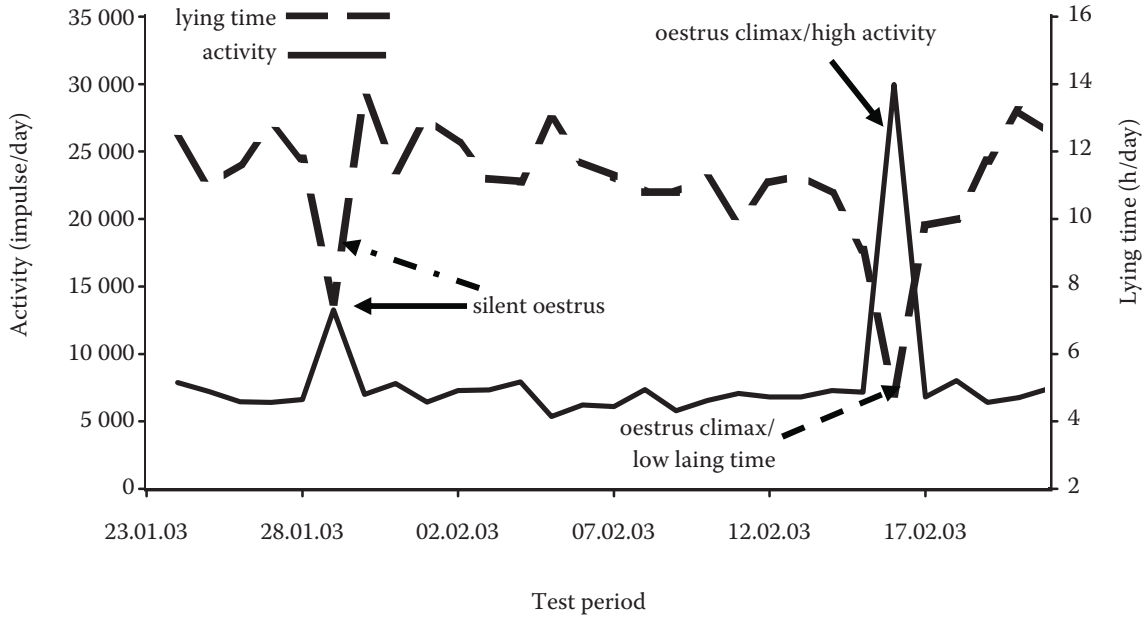


Figure 3. Course from lying time and activity at an experimental animal with silent and normal oestrus (Brehme *et al.* 2004)

analysis shows that different aspects regarding the difficulties in recognizing quiet or weak oestrus can be mentioned here. The number of registered oestrus cycle between 06:00 p.m. hours and 06:00 a.m. hours is possible 60% we find out a very low reconnaissance instalment of oestrus cycle symptoms by the stable staff. The reason for this is the non-visual monitoring in the night period in the stable. For the whole test period we registered together 38 oestrus cycles by ALT pedometer system at our experimental animals. From it 23 detected oestrus cycles fall in the night period between 06:00 p.m. and 06:00 a.m. These cycles very often are short and not typically distinctive, they are called "quiet oestrus" or "silent oestrus" and are only seldom stated by the stable staff in the next morning. Consequently half of all cycles occur after completion of the stable work when no or only occasional oestrus cycles checks are carried out. The ALPRO system lies with 23 recognized oestrus cycles clearly under the recognition rate of the ALT pedometer, in addition the oestrus announcement from ALPRO system came always one day later than from the ALT pedometer. Have to be named as reasons for these results: ALPRO only works with a measuring parameter (activity), the data transmission from the actiometer to the PC is carried out when milking only twice daily. The pedometer system transfers the stored measuring data in a cycle of four hours to the PC or laptop. As a result of reduced oestrus intensity and mating season duration quiet oestrus and shorter, less intensive cycles then no longer recognized. The cycles with weak oestrus intensity or quiet oestrus recog-

Table 2. Results from ALT pedometer in the function test with ALPRO activity meter (Brehme *et al.* 2004)

Animal number	Pedometer number	Pregnancy control	Result of pregnancy control	Veterinarian therapies	Detected oestrus cycles by ALT pedometer	Inseminations
426786	P1	06.07.2004	pregnant	3	3	1
829575	P2	06.07.2004	pregnant	3	3	1
426610	P3		no pregnant	–	6	4
852740	P4	01.06.2004	pregnant	–	3	1
829554	P5		no pregnant	3	4	5
829502	P6	16.07.2004	pregnant	–	4	3
829543	P7		no pregnant	2	6	8
852846	P8	15.06.2004	pregnant	3	2	1
829530	P10	12.08.2004	pregnant	3	5	3
829564	P11	18.05.2004	pregnant	–	4	2

nized by ALT pedometer very frequently show oestrus symptoms only under the measuring parameter "lying time". In these phases the cows on an oestrus cycle do not lie down for many hours. The reason is, cows in heat have great trouble with her partners in the group. They attack the cow in heat, they will mount the cow, they never get quiet. A cow in heat is restless in this time and does not find time for lying down. These results you can only see in the values from measurement parameter "lying time". In our investigations we found out that cows in heat do not lie down for 6 to 17 h in time of oestrus cycle. In Figure 4 an example of silent oestrus is represented as a graphic. In this example the activity impulses are not elevated as is typical in oestrus, but instead are encountered frequently, yet at a low level. In a measurement system where only the activity is recorded with a normal pedometer, this form of the "quiet oestrus" cannot be recognized even by an experienced expert. Reliable, plausible measurements are an important herd management criterion for oestrus detection in dairy cattle farms (Brehme *et al.* 2004). Table 2 shows the results from insemination and pregnant cows in our investigation.

In the investigation time of seven months were pregnant from 10 test animals seven again. However, the relatively good result also points which was necessary in addition a not satisfactory expenditure in inseminations per animal and a crowd of veterinary measures. The index of insemination in this farm is 4.1 and is not acceptable. In case of a differentiated analysis of the results it turns out that only two cows become pregnant after the first or second insemination. With another three laboratory animals, however, three veterinary treatments were always necessary for a successful first insemination with pregnancy. The remaining results with four, five and eight inseminations point clearly, which must be changed in the herd management of the company, especially at the fertility of the animals.

Earlier examinations with a more sensitively set boundary value on the pedometer resulted in an increase in the number of oestrus cycles recognized. This shows the problem of using only one measuring parameter (activity) for improvement in oestrus detection forecast.

Figure 3 shows a quiet and a normal oestrus cycle of a test animal. The insemination on February 16th led to successful gestation. The animal is also a typical example of short cycle lengths and night-time oestrus occurrence. Both cycles are only 18 days apart, with the start of the quiet oestrus at 08:00 p.m. The daily lying time difference between the quiet and normal oestrus is 2.5 h. This makes it clear that more short rest periods occur during quiet oestrus than during a normal cycle (Brehme *et al*. 2004).

The level of activity impulses per day shows a similarly course, being twice as high in normal oestrus than in the case of quiet oestrus.

The following Figure 4 is characteristic of the course of the lying time in the oestrus cycle. In a normal oestrus cycle it is not rare for animals in heat not to rest at all or only for a few minutes per hour. In these examples is shown that the cow did not lie down for 16 h. The crucial advantage of the ALT pedometer system is the mutual complementing of the measuring parameters activity and lying time.

CONCLUSIONS

In dairy husbandry the improvement of animal health and fertility is a crucial objective. It is important to develop the reserves of each individual animal. Only in this way can the farm results be sustainably improved and stabilized. In the results of our investigations we can draw the following conclusions:

- The development of a new sensor-aided measurement system for improvement in oestrus detection and animal illness for cattle was a right decision.
- The identification rate of cows „positively on heat" could be increased to > 90%, the share of „wrongly positive" cows was approx. 10%.
- Through combination of two important physiological parameters, activity and lying time, we get better results in oestrus detection and animal illness. The higher interdependence and combination of these measuring parameters allow safe and exact oestrus cycle forecasts. The new system also allows early forecasts of animal illness (lameness, metabolic illnesses).
- We recognize more oestrus cycles over the day, we recognize the cycles earlier and faster.
- The improved cycle recognition is attributable to the fact that approx. 60% of all oestrus cycles start after the end of the stable work between 06:00 p.m. and 06:00 a.m. Oestrus cycle controls are not conducted continuously during this period on dairy cattle farms. Shorter mating season durations and oestrus intensity make visual observation and recognition of oestrus cycles more difficult.
- For better results in fertility and animal health it is significant that dairy cattle farms without technical systems have to extend and intensify visual oestrus monitoring during evening and night hours too.

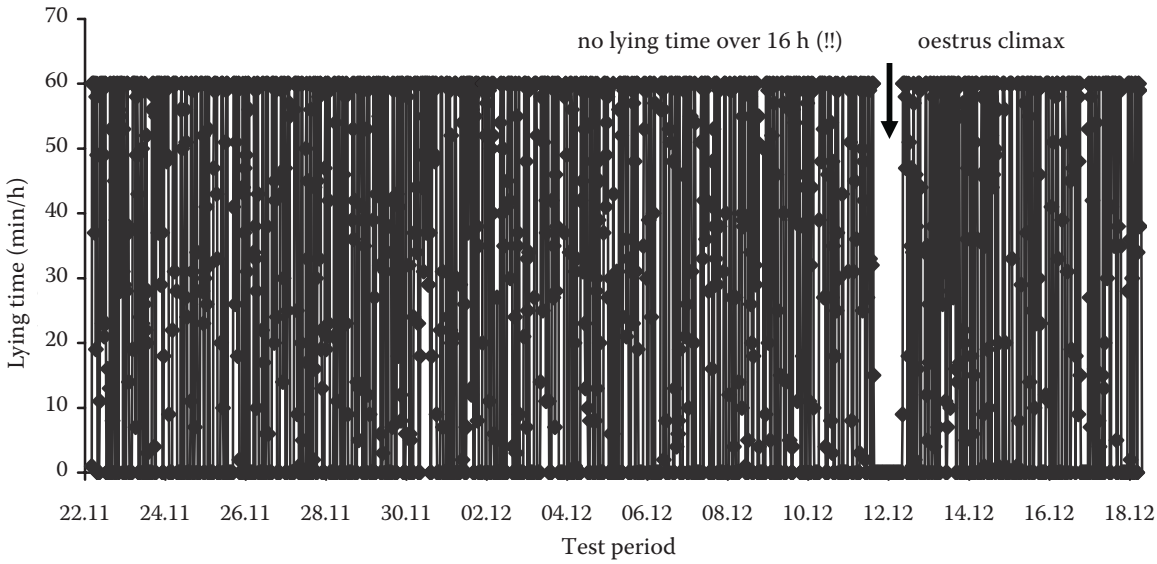


Figure 4. Result for typical course from lying time in oestrus cycle – cow has no time for lie down 16 hours (Brehme *et al.* 2004)

– In June 2005, a known milking machines manufacturer has acquired the licence of the ALT pedometer system.

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Received for publication November 2, 2005
Accepted after corrections November 24, 2005

Abstrakt

Brehme U., Stollberg U., Holz R., Schleusener T. (2006): **ALT pedometr – nový, senzory podporovaný, měřicí systém dokonalejšího zjišťování říje**. Res. Agr. Eng., **52**: 1–10.

Bez měřicích systémů, podporovaných senzory, lze zjistit méně cyklů říje, protože délka cyklu, trvání a intenzita říje se při vysoké užitkovosti zvířat vyvíjejí negativně. Tento vývoj přesvědčivě ukazuje, že pozorování období zapouštění u dojnic je ještě důležitější, než se dosud předpokládalo, nemají-li finanční ztráty, způsobené nedostatečnou fertilitou stáda, podniku přivodit ekonomické problémy. Elektronická identifikace a měřicí systémy představují klíčové technologické prostředky, umožňující postupnou automatizaci chovu hospodářských zvířat v moderní, perspektivně zaměřené živočišné výrobě. Ta vyžaduje vhodné objektivní měřicí systémy, umožňující rychle a bezpečně zjišťovat onemocnění zvířat, normální cyklus říje, tichou říji a následky stresu zvířat. Pedometry a transpondéry různých výrobců hrají při měření údajů o zvířatech a při monitorování jejich zdravotního stavu a cyklu říje důležitou roli. Moderní snímače (senzory, biosenzory) v rostoucí míře umožňují aplikaci metod neinvazivního měření a přenosu dat a rozhodujícím způsobem zlepšily potenciál měření údajů o zvířatech. Byl vyvinut nový typ pedometru, označeného jako pedometr ALT, který je určen pro měření tří parametrů (aktivity, času stráveného ležením, teploty), pro sledování procesů v reálném čase a umožňuje změnu intervalu času měření. Nový systém umožňuje volbu různých časových intervalů od 1 do 60 minut při kontinuálním měření. Výsledky při detekci říje jsou vynikající. Vysoká shoda mezi měřenými parametry aktivity a čas ležení umožňuje včasné a spolehlivé zjišťování onemocnění zvířat a časových údajů cyklu říje.

Klíčová slova: detekce říje; pedometry; senzory; dojnice

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