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Indicators for monitoring behavior and health of group housed pregnant sows

In a collaborative research project, funded by the BLE, the partners in this project University of Hohenheim, Claas Agrosystems KGaA mbH & Co KG and gridsolut GmbH & Co. KG are going to develop a model for monitoring changes in health and behavior of group housed pregnant sows. The overall aim is to implement this monitoring model into a management system, so farmers can use it for managing purposes. This article will demonstrate the methods and present first results of preliminary experiments.

Keywords

Health monitoring, pregnant sows, group housing, indicators

Abstract

Landtechnik 67 (2012), no. 5, pp. 326–331, 5 figures, 1 table, 7 references

Several investigations analysing behavioral changes in terms of feed intake, water intake and locomotion of sows are reported in the literature. Investigation aims were directed at finding ways of using these as indicators e.g. for the early recognition of health problems. Based on data from an electronic feeding station (EFS) [1] statistical models have already been developed which provide information about return to heat, lameness and other health problems. Hereby a very high specificity (rate of correct negative findings) was obtained for the prediction of return to heat (81.0–95.4 %), lameness (80.3–95.4 %) and other health problems (79.0–95.4 %). A lower sensitivity (rate of correct positive findings) for return to heat (59.0–75.0 %), lameness (71.0–70.0%) and other health problems (0–75 %) was characterised by too many false positive predictions. In a more recent investigation [2] which uses the individual animal visiting time at an EFS, it could be shown that there is a tendency for sows to enter the EFS later on the days that they have been handled than on those that they have not been handled. In an investigation into the drinking behavior of young pigs [3] using drinking patterns as the basis for an online monitoring, a diarrhoea disorder could be predicted 24 hours before any clinical symptoms. Similar results were obtained with time measurements of feeding pigs at the trough [4]. Here it was shown that animals that were being treated against lung infections already spent less time at the feeding trough two days before the treatment began compared with untreated animals. Less well investigated so far is to what extent various diseases affect the locomotion of sows. Lameness in particular is one of the main causes of sows leaving the breeding herd early [5]. In the context of cattle farming it has been established with the help of pedometer data that lame dairy cows exhibit shorter idle periods and a lower feed intake compared with dairy cows that are not lame [6].

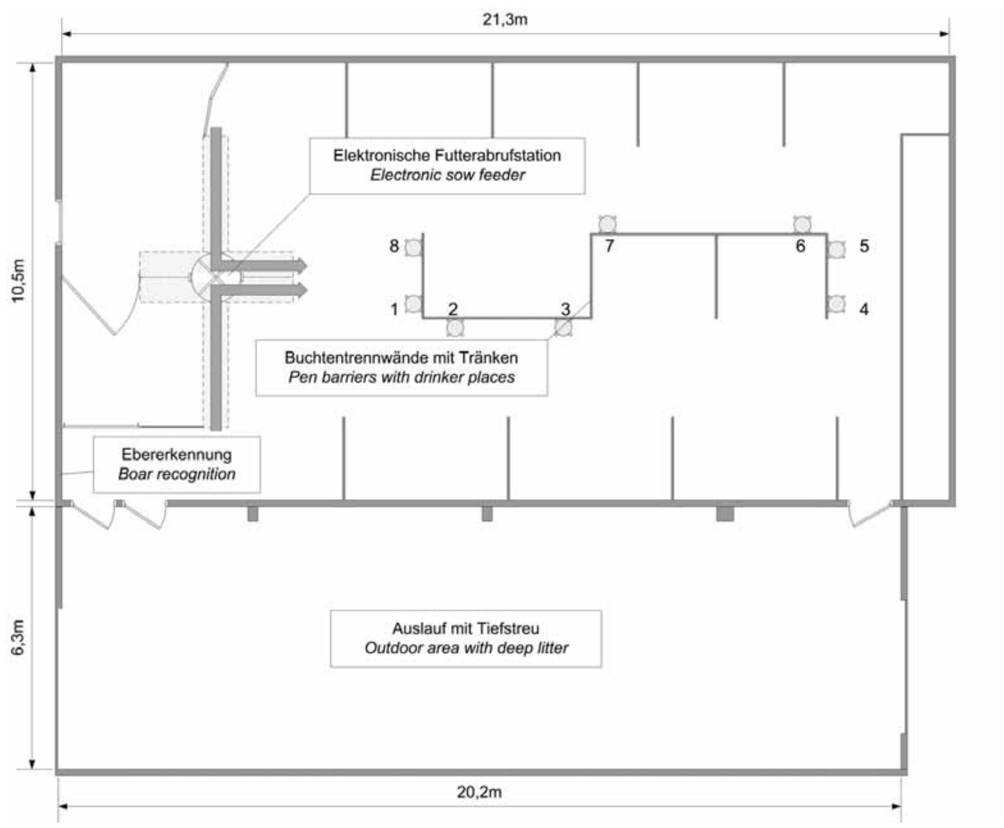
When creating an indicator based monitoring model for the prediction of behavior or health changes it should be noted that the characteristics and variance of the indicators both between animals and also individually can be very different. With a view to methodology it should be considered that different diseases or health impairments can be accompanied by varying symptoms and time courses. A further challenge is presented by the fact that some illnesses only occur very seldom and this results in limitations for the statistical possibilities and modelling.

Thus in the first phase of the project the object is to gain information about the inter and intra animal variability of feed intake, water intake and locomotion of pregnant sows in group housing. After taking data from a research farm a monitoring model is created and then this is later tested on the research farm and also on a practical farm.

Experimental housing and test animals

Data was taken in a sow gestation stall at the Agriculture experimental station, sublocation Unterer Lindenhof of the University of Hohenheim. In the experimental housing, the service area and some sick bays are located next to the gestating sow group with a neighbouring boar pen. The gestating sows are held in a dynamic large group of about 75 to 80 animals. A one week rhythm is followed on the experimental farm that means that every week about eight serviced sows are integrated into the group and about eight sows close to farrowing leave the group. Feeding takes place at two EFS (Schauer Agrotronic GmbH). Water can be drunk ad libitum by the sows at eight un-

Fig. 1



Ground plan of the group housing stable for 80 pregnant sows at the experimental farm

restricted drinking troughs with pin valves. The approximately 220 m² barn is fitted with a slatted floor over most of the activity area and with a solid concrete floor with minimal litter in the lying area. The sows can in addition unrestrictedly use an approximately 124 m² outdoor area with deep litter (**Figure 1**).

Procedure

All gestating sows are fitted with a passive ISO earmark transponder (low frequency) by which identification in the EFS is made on a radio frequency identification (RFID) antenna and thereupon output of feed and water is dosed out. The following raw data are collected from the EFS about the station visits and the feed output (**Table 1**):

Information on heat detection or boar recognition is also collected by PC from the EFS. Heat detection or boar recognition involves a device whereby the sows can make contact with the boar through a hole shielded by a metal grid in the wall separating the boar pen (**Figure 2**). When the sow pushes her head through the opening it is detected in the same way as in the EFS by an RFID antenna. Thus an individual animal protocol is made every day in which the time the sow spent in the heat detector is added up. The lengthy presence of a sow can be evidence of an interest in the boar and thereby indicate return to heat by the sow.

In order to register the water intake of individual animals each water pipe was fitted with a water flow meter. This relayed the measured impulse to a counter module which transmitted via Ethernet the totalled values every second for each drinking trough to a data pooling PC (**Table 1**). The recognition of animals was done in the same way as in the EFS and boar recognition by means of RFID antennae placed to the right of the tanks (**Figure 3**). The detection field of the RFID antennae is shielded on the right-hand side in order to prevent incorrect animal recognition due to neighbouring animals.

For recording locomotion behavior for the test animals there is no automated system at the moment, which provides reliable, precise and cost-efficient detection of activity and position-change recording of pigs in a large group over time. The use of pedometers as for dairy cows is difficult to transfer to pigs as pedometers placed on the body become damaged due to the distinctive play instinct of the animals.

Since the breeding sows are already being automatically registered several times daily at various positions by the recognition systems (EFS, heat detection and drinking), use should be made of this information (**Table 1**). In addition the sows should be registered when entering and exiting the outdoor area. For this, RFID antennae are also placed at the entrance and exit gates of the outdoor area. From the time sequence of the different detection points at least a theoretical minimum distance travelled for each animal can be ascertained. Whether a correlation can be derived between the theoretical minimum distance travelled and the actual distanced travelled is presently being investigated with the help of direct observations.

Together with the automatic recording of behavior patterns, further information about the health of the sows is needed. For this purpose every animal is monitored twice weekly for walking ability, skin wounds, fever, vaginal discharge, diarrhoea and rapid breathing. The animal-specific walking ability is evaluated with a four-category "locomotion scoring" system (0 = normal, 1 = slight lameness, 2 = clear lameness, 3 = lameness on two feet, sow can hardly walk) [7]. Skin wounds and other abnormal features were at first only determined in the preliminary examination on a two-category yes/no principle. It is presently being evaluated whether a more detailed differentiation is possible, necessary and purposeful.

All the raw data from the EFS, boar recognition, water flow counters and RFID recognition, ventilation computer, data taken manually from animal monitoring and direct observations, animal stock and treatment data from the management software (sow planner) was filed in a central database for further evaluations.

Fig. 2

Boar recognition with metal basket and RFID-antenna

Example results

The quantity of water registered for several days in June 2012 by the flow meters at the eight troughs is presented as an example in **Figure 4**. It can be clearly seen that every day the largest flow of water by far was recorded at trough 3 followed by troughs 1 and 2. The other troughs 4 to 8 were either not used at all or used very little. Whether there is a reason for the preferential use of the three troughs 1, 2 and 3 and whether, for example, this is due to the spatial layout of the troughs is presently being investigated. Individual animal specific preferences for one or the other troughs can also not be excluded. In **Figure 4** the average quantity of water dispensed per sow and day is also presented. This fluctuates only slightly between 9.6 and 10.8 l (sow · d)$^{-1}$. The individual animal specific drinking behaviour will be considered in further evaluations with regard

Table 1

Raw data from the electronic sow feeder (ESF), boar recognition, water flow meters and RFID-antennas

Rohdaten EFA ***Raw data from ESF***	Datum/*date*
	Uhrzeit erste Identifikation/*time of first recognition*
	Uhrzeit letzte Identifikation/*time of last recognition*
	Stationsnummer/*station number*
	Tier-ID/*animal ID*
	ausdosierte Futtermenge/*dosed feed stuff*
	Futterrest/*feed remains*
	Besuche mit Futteranrecht/*entering ESF with right to eat*
	Besuche ohne Futteranrecht/*entering ESF without right to eat*
	Tiergewicht/*animal weight*
Rohdaten Ebererkennung ***Raw data from boar recognition***	Datum/*date*
	Uhrzeit erste Identifikation/*time of first recognition*
	Uhrzeit letzte Identifikation/*time of last recognition*
	Tier-ID/*animal ID*
Rohdaten Wasserdurchflussmesser ***Raw data from water flow meter***	Datum/*date*
	Sekündliche Zählerstände/*meter reading every second*
	Nummer Durchflussmesser/*number flow meter*
Rohdaten RFID-Antennen ***Raw data from RFID-antennas***	Datum/*date*
	Zeit/*time*
	Tier-ID/*animal ID*
	Nummer RFID-Antennen/*number of RFID-antenna*

Fig. 3

Drinker place with separation and RFID-antenna

to the expected extent of influence of, e.g., age, weight, temperature, pregnancy and stage of pregnancy.

In further steps the effect of disease or return to heat events must be analysed in more depth. As a first example should serve the pattern of feed intake, water intake, the number of separate drinking events and the locomotion scores for a sick sow represented in **Figure 5**. On May 2 the animal had to be removed from the group due to coronary band inflammation and fever. Already on April 29 the animal consumed distinctly less water at the trough compared with the previous days (7.6 l). This continued on April 30, and on May 1 the water intake had fallen to only 2.7 l. Noteworthy is also the decrease in drinking events from six on April 30 to not one single drinking event recorded on May 1. That means that the animal had only drunk water at the EFS which automatically dispenses water with the feed. Also with regard to the quantity of feed, on April 30, two days before the diagnosis, only 3.0 kg was dispensed before the sow left the EFS (maximum possible feed quantity 3.6 kg). On the following day, May 1, distinctly less feed (only 1.4 kg) was dispensed for the sow. On the day of the diagnosis the animal left the EFS after only 1.1 kg feed had been dispensed. The worsening of the walking ability from locomotion score 1 ("slight lameness") on April 24 to 3 ("lameness on two feet, sow can hardly walk") on May 2 also clearly illustrates the worsening health of the animal.

Conclusions and outlook

The example results presented here from the preliminary investigations show that health disorders of pregnant sows in group housing can be indicated in measurable changes in behavior. However, the extraction of information on variations in feed intake, water intake and locomotion behavior and the parallel manual data retrieval on the health condition of the sows, takes time. Also, potential ways must be further differentiated for the evaluation scoring while monitor the sows. Furthermore, another approach is possibly needed for the automatic registering of movement. A first monitoring model will be created and subsequently tested on both the research farm and on a commercial farm.

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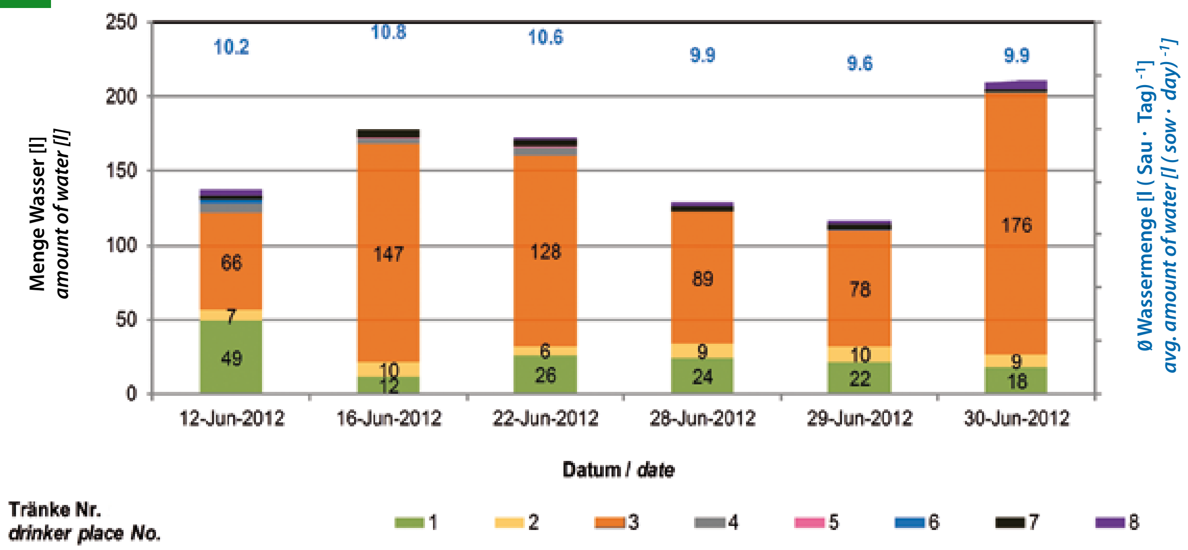
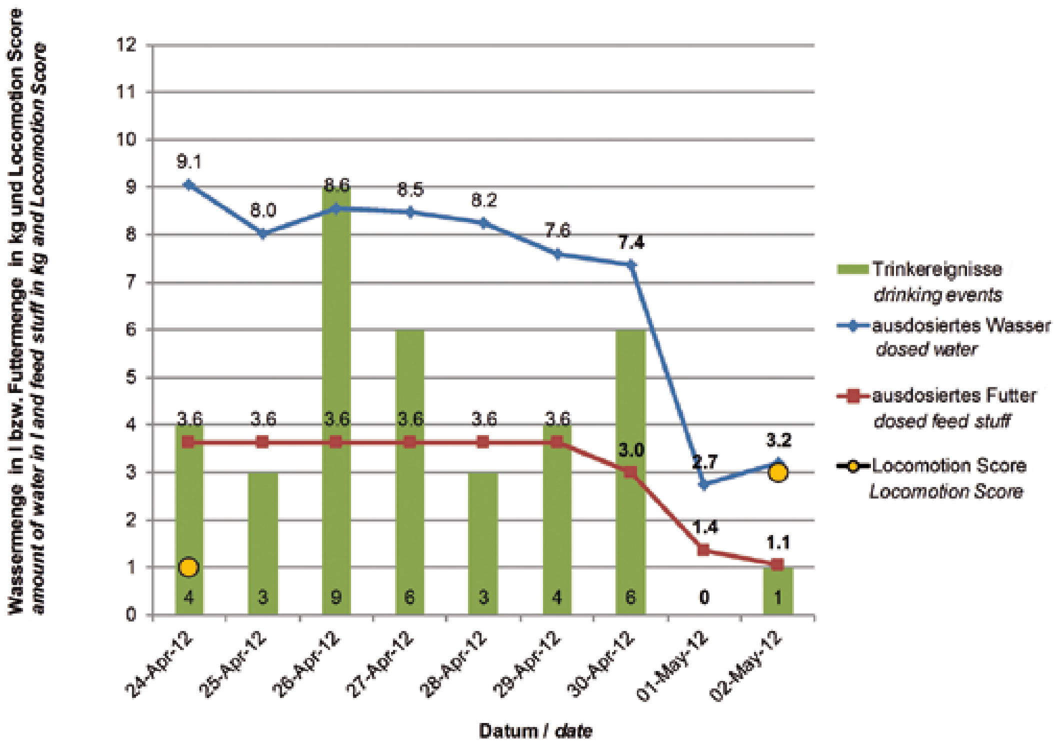
Fig. 4



Distribution of measured amounts of water at eight freely available drinker places in a group of 75 to 80 waiting sows

Fig. 5



Water intake, feed intake and locomotion score (0 = normal, 1 = slight lameness, 2 = clear lameness, 3 = lameness on two feet, sow can hardly walk) of a sow with health disorders

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Acknowledgement

The project is supported by funds of the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support programme. Funding ID 313-06.01-28-13700110