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Research Paper

Classification of nest-building behaviour in non-crated farrowing sows on the basis of accelerometer data

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The objective of the study was to test the effectiveness of classification, on the basis of accelerometer data, of nest-building behaviour in farrowing sows that are not confined in crates. The experiment took place in the research farm of University of Veterinary Medicine Vienna, using a herd of 120 Edelschwein sows. Data were collected from 9 sows housed in farrowing pens. The behaviour of 9 sows was video recorded and labelled for a period of 24 h before farrowing, with focus on nest-building activities. Each sow had a specific ear tag with an 3 axis accelerometer sensor mounted on the ear. Acceleration was measured at a frequency of 10 Hz. Out of nine sows under observation, six were assigned to the training set and three as a test set. Classification of nest-building events in the test set using accelerometer data with the generalised linear model indicated sensitivity of 87%, specificity of 85% and accuracy of 86%. The developed technique can be used as part of a Precision Livestock Farming (PLF) automatic monitoring system, where PLF can be defined as management of livestock production using the principles and technology of process engineering. On-farm application of the system would give the possibility to keep sows unconfined until the end of nest-building period. Thus, crating of individual sows could be limited to the first few days after farrowing when the risk of piglet crushing is high. This would improve welfare of sows, without an increase in piglet mortality and without extra labour demand for observation.

1. Introduction

Nest-building is an important behavioural trait in domesticated, feral and wild sows (Lent, 1974). Female pigs build nests in order to protect piglets against heat loss (Briedermann, 1986), unfavourable weather conditions, predators (Pullar,

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1953), trampling by other adult pigs (Jensen, 1986) and to facilitate mutual bonding with the offspring (Jensen, Florén, & Hobroh, 1987). The onset of nest-building is internally triggered by hormonal changes. Specifically, decline in progesterone concentration starts 72 h before farrowing while increase in prolactin starts 24 h before farrowing (Algers & Uvnäs-Moberg, 2007). Due to hormonal changes and presence of external stimuli, nest-building starts 24 h before parturition, reaches maximum frequency 6–12 h before parturition and then decreases as parturition approaches (Castrén, Algers, de Passillé, Rushen, & Uvnäs-Moberg, 1993). Nest-building in natural conditions is performed in two consecutive phases: initially the ground is rooted and pawed and a shallow hole is dug. In the second phase, the sow collects, carries and arranges the nest material along the edges of and in the nest (Per Jensen, 1993).

In modern intensive pig production, sows are usually kept on concrete or plastic floors and in narrow crates before and also during farrowing (Anon, 1997). These conditions prevent much of the nest-building behaviour (Wischner, Kemper, & Krieter, 2009). Limited possibilities for sows to build a nest lead to increased plasma cortisol levels (Lawrence, McLean, Jarvis, Gilbert, & Petherick, 1997), oral and nasal stereotypies such as bar biting (Jensen, 1988), repetitive pressing of the snout against a surface (Vestergaard, 1984) and straw chewing (Horrell, A'Ness, Edwards, & Eddison, 2001). In the crates, animals may grind their teeth, bite and root at the rails and change position frequently between standing and lying (Heckt, Widowski, Curtis, & Gonyou, 1988). Unsatisfied behavioural needs and idle activities can cause injuries and apparent exhaustion in the sow (Hansen & Curtis, 1980). Allowing the sow to perform nest-building, or at least some elements of it, leads to better health and welfare of both the sow and the piglets (Algers, 1994). Therefore, the possibility to perform nest-building behaviour should be offered to all sows in modern management systems. For this possibility, space and the provision of adequate nest-building material are two relevant prerequisites (Wischner et al., 2009).

In comparison to crated systems, in loose housing systems (i.e FAT2, Schmidt, PigSAFE) sows perform more elaborate nest-building behaviour that starts earlier and lasts longer (Thodberg, Jensen, & Herskin, 2002). Thus, keeping sows in loose systems offers possibilities to improve nest-building behaviour.

However, the risk of piglets being crushed is increased when sows are not confined in crates (Edwards & Fraser, 1997). In order to provide the sow with the freedom to build a nest and simultaneously keep the piglet survival at the same level or higher than in crates, a concept of temporary crating has been developed. Crating the sow only in the critical period of crushing risk can limit piglet loss due to crushing while nest-building behaviour can still be performed (Moustsen, Hales, & Hansen, 2012). This concept contributed to a change in Austrian Welfare legislation in 2013. According to Austrian Animal Welfare Directive (Bundesministerium für Gesundheit Österreich, 2012), farrowing systems have to enable free turning and movement of a sow (minimum pen size > 5.5 m^2). Additionally confinement of sows in a farrowing crate is permitted in the critical period of piglets' lives. This means in a period from the beginning of farrowing until few days after farrowing when risk of piglet crushing becomes lower. The regulation will become mandatory in 2033.

Choosing the right moment to crate an individual sow in farm conditions, in a way that makes nest-building possible and risk of piglet crushing low, is challenging. Due to the biological variability in gestation length, time-consuming observation of sows would be necessary. On the other hand, confinement of sows based on a calculated farrowing date of the group would either disturb adequate nest-building or the farrowing process in many sows in the group.

A promising way to overcome these constraints is the use of sensor-based methods of Precision Livestock Farming (PLF) (Wathes, Kristensen, Aerts, & Berckmans, 2008). Compared with traditional livestock management, PLF has the potential to monitor, manage and control many aspects of livestock production, both simultaneously and automatically (Wathes et al., 2008). Stockmen could be provided with detailed information about animal processes, such as behaviour, and this would allow more time for inspection (Frost et al., 1997).

Previous attempts to monitor behavioural patterns at the onset of farrowing used infrared photocells and force sensors mounted in the farrowing crates (Erez & Hartsock, 1990; Oliviero et al., 2008). Force sensors were applied for detection of onset of farrowing on the basis of increased activity of a sow during the nest-building phase. The force sensor recorded a significantly higher number of peaks in the 24-hr interval prior to farrowing than in all the other 24 h intervals monitored (Oliviero et al., 2008).

Besides photocell and force sensors mounted in the farrowing crates, accelerometers mounted on the animals have been used for classification of sow activity types at the onset of farrowing (Cornou & Lundbye-Christensen, 2008; Cornou, Lundbye-Christensen, & Kristensen, 2011) and in different stages of gestation (Ringgenberg, Bergeron, & Devillers, 2010). Results indicated high levels of correct classification of activity types, marked increase of active behaviour and decrease of lying laterally starting 20–16 h before the onset of farrowing (Cornou et al., 2011).

The objective of our research is to develop and validate a method for classification of nest-building behaviour in sows on the basis of accelerometer data. The purpose of the PLF monitoring technique is to detect nest-building behaviour in loose-housed sows that are temporary crated just for the critical period around farrowing. The monitoring technique should help both to allow adequate nest-building behaviour of sows and give precise information to stockmen when a sow can be crated prior to farrowing for protection of piglets.

2. Materials and methods

2.1. *Experimental setup*

2.1.1. *Animals and housing*

Experiments were conducted between June and September 2014 at the experimental farm of the University of Veterinary Medicine Vienna. In total, nine Austrian Large White sows were included in the experiments. The sows were kept in three types of farrowing pens with possibility of