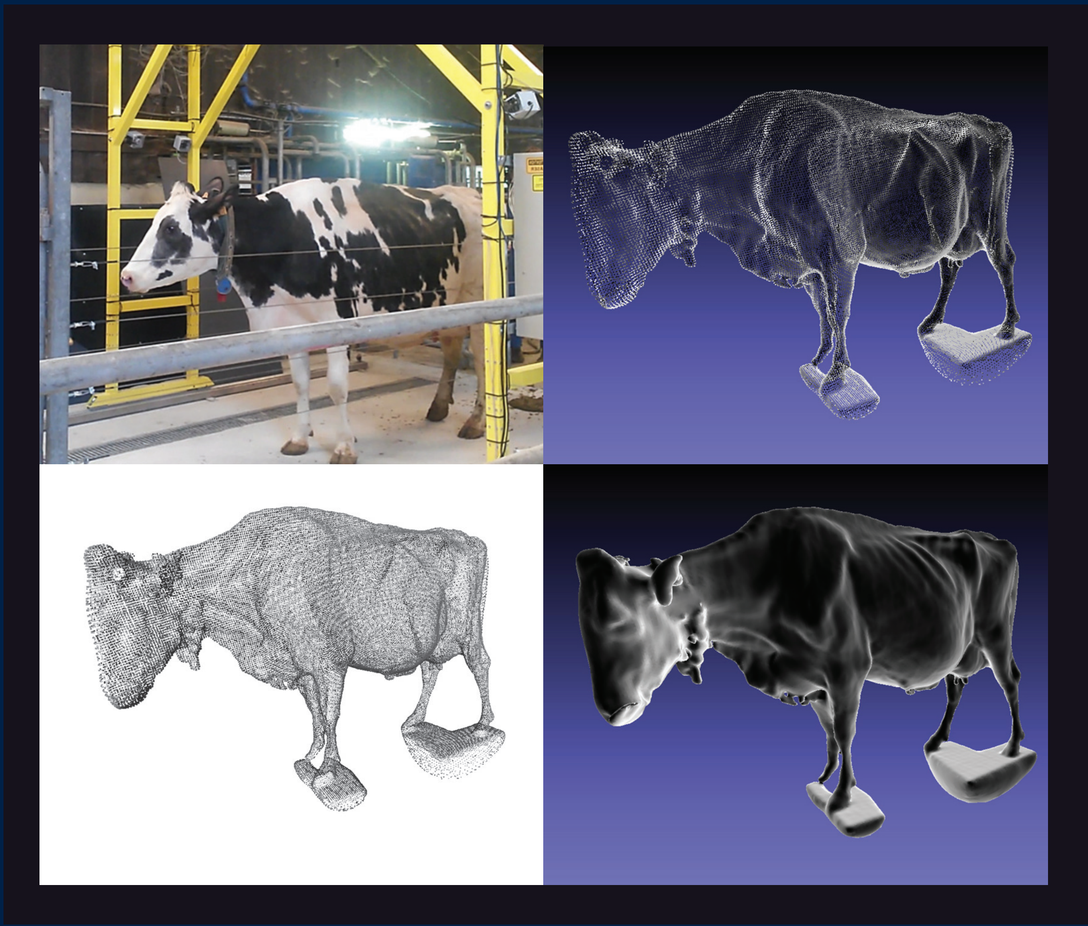

Precision Livestock Farming '17

Edited by D. Berckmans and A. Keita

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Papers presented at the 8th European Conference on Precision Livestock Farming

Nantes, France
12-14 September '17

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Monitoring of the individual drinking behaviour of healthy weaned piglets and pregnant sows

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Abstract

Trials were conducted at the Ifip experimental station in Romillé (Brittany, France) to assess the individual drinking behaviour of healthy weaned piglets and pregnant sows. A special connected drinker was developed to collect this type of data. It is composed of an anti-wastage bowl drinker surrounded by shoulder partitions, a precision water meter (± 0.01 l for piglets and ± 0.1 l for sows) and a RFID (Radio Frequency IDentification) antenna to detect animals near the drinker by means of the individual electronic ear tag on each pig. Observations on animals were carried out twice a week to evaluate their health status. This study only focuses on healthy animals. Weaned piglets were bred in pens of 19 animals. The individual water consumption was 10.7% of body weight on average. Sows were bred in a dynamic group equipped with 6 connected drinkers and automatic feeders. On average, the daily water consumption was 8.2 l/day (1.6 l during the meal and 6.6 l directly at the bowl drinker). For the two types of animal, there is large inter- and intra-individual variability in terms of water consumption (more than 30%). Thus, it appears to be difficult to determine the health status of piglets or sows on the basis of drinking behaviour only. The next step is to combine this information with other data (feeding system, automatic weighing station, accelerometer, etc.) to identify a behavioural pattern in healthy animals.

Keywords
Drinking behaviour, connected drinker, water consumption, pig, monitoring, healthy

Introduction

Drinking behaviour and water consumption of pigs seem to be an interesting indicator which may provide a good understanding of their health status. Indeed, several authors have found that an animal may modify its feeding and/or drinking behaviour at the onset of disease (Pijpers *et al.*, 1991; Andersen *et al.*, 2014). This modification may occur a few hours before the start of the first clinical symptoms observed by an operator (Madsen and Kirstensen, 2005; Brumm, 2006).

Early prediction of disease may be an innovative way of reducing antibiotic usage, by treating sick animals more promptly in order to reduce the transmission of pathogens to others or by treating only sick animals instead of the whole group. For more effective early prediction of disease, it is essential to collect individual data because collective drinking behaviour can hide a large amount of variability.

Thus, one of the goals of this study was to develop and validate a technology which was capable of recording the individual drinking behaviour of weaned piglets or pregnant sows. It would be used to determine the water consumption patterns of healthy pigs.

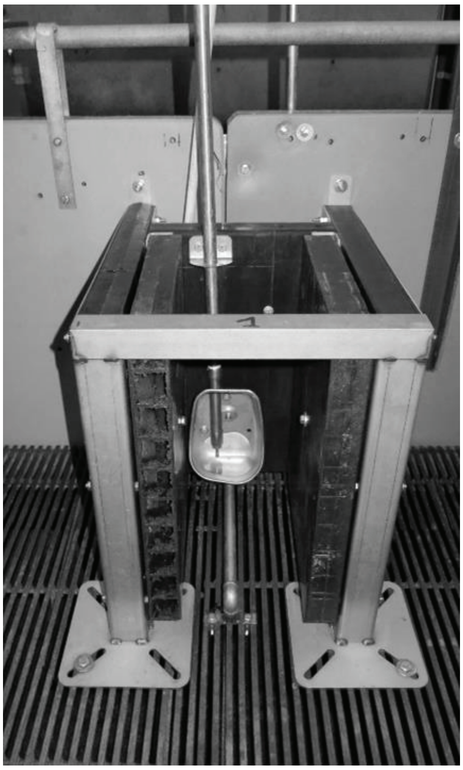
Materials and methods

Trial periods

The trial using weaned piglets took place from 4th June to 16th July 2015. The first few days of the trial were used to design and test connected drinkers, which is why the results relate only to the last 22 days of post-weaning (from the 47th to the 69th day of age). The trial using sows took place over 58 days, from 4th May 2016 to 30th June 2016.

Connected bowl drinker

An automatic system was developed with a French firm specialising in animal livestock housing (Asserva) in order to isolate and identify pigs in front of the drinker then to record their individual drinking behaviour. This automatic system, known as Aqualab, is composed of an anti-wastage bowl drinker surrounded by shoulder partitions, a precision water meter (± 0.01 l for piglets and ± 0.1 l for sows) and a RFID (Radio Frequency IDentification) antenna to detect animals near the drinker by means of the individual electronic ear tag on each pig (Figures 1 and 2). This automatic system was connected to a computer which recorded water quantity used and duration of each visit. The amount of water recorded included actual consumption by the pig and water wastage, this latter being considered a part of the natural drinking behaviour of the pig.



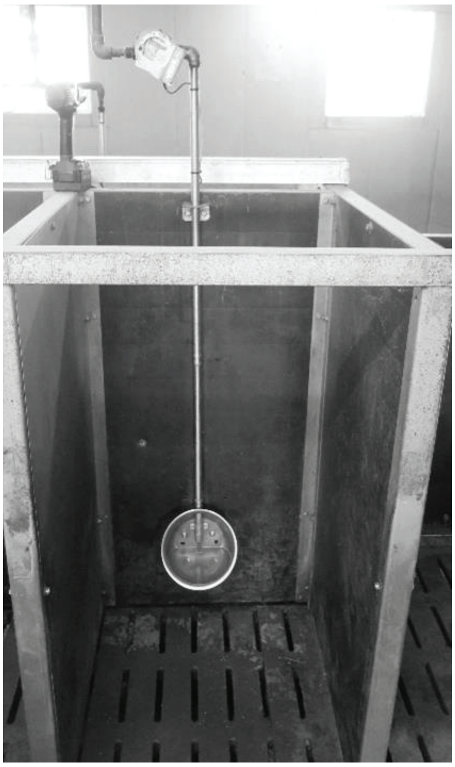


Figure 1: Connected drinker pregnant sow

Figure 2: Connected drinkerfor for piglet

Housing conditions

Tests were carried out at the Ifip experimental station in Romillé (Brittany, France).

- Weaned piglets: After weaning, 228 piglets, 28 days old, were allocated to 12 pens of 19 animals. Three weight groups were created with four pens each (heavy, medium and light with a mean weight of 11.1 kg, 9.1 kg and 7.0 kg, respectively). Piglets were individually weighed every 14 days. As shown in Figure 3, six pens had a traditional bowl drinker and the others had a connected drinker (Aqualab). The water flow was set to 1 l/minute and checked every 14 days. The daily water consumption of the twelve pens was recorded. Pens were heated to 28°C at the start of post-weaning and the temperature was gradually reduced to 24°C by the end of the trial.
- Pregnant sows: 83 sows (3 different batches with 3 different gestation periods) were housed in a dynamic group. They were fed individually with automatic feeders by means of their electronic ear tags. They were given dry food but some water (0.5 litre / kilogram of feed) was automatically added inside the trough to meet the needs of the capacitive sensor which detects the remaining level of food. Sows were weighed every day by an automatic weighing station located at the exits from the

feeders. Six connected drinkers were installed (Figure 4). The water flow was set to 3 l/minute and checked every 14 days. The temperature in the pen was maintained at around 21 °C throughout the trial.

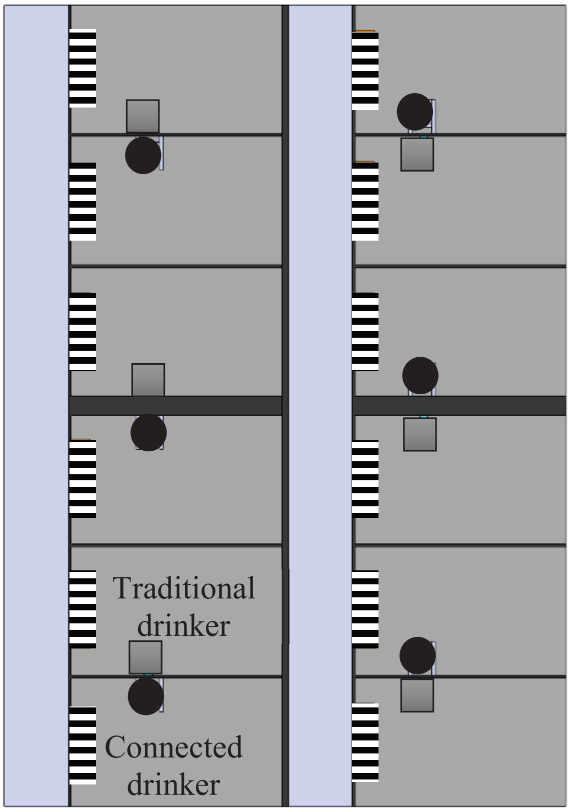


Figure 3: Housing conditions of piglets (black horizontal lines for feeding system, circle for connected drinker and square for traditional drinker)

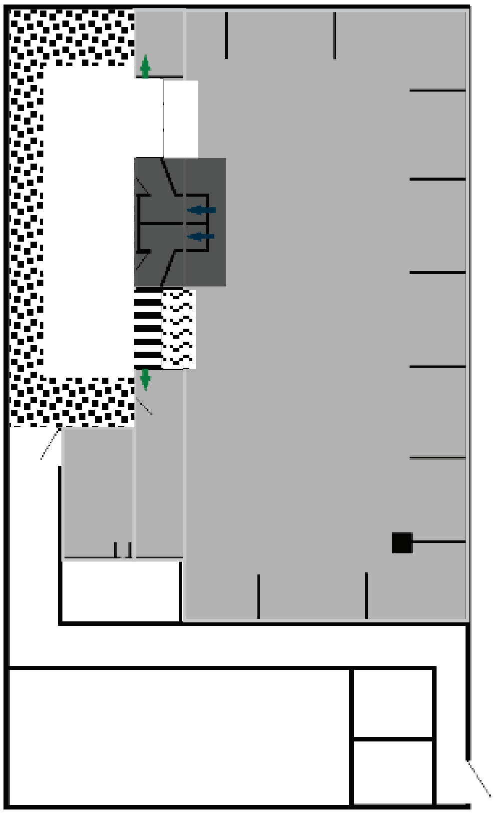


Figure 4: Housing conditions of sows (grey for living area, dot for selected area, black wavy lines for connected drinker, black for automatic feeder and black horizontal lines for weighing station)

<u>Health status of the animals</u>

Each day, animals were observed by the staff of the station to assess their health status. Specific attention was paid to the most frequent diseases observed in pig barns: locomotor and urinary disorders for sows and digestive and respiratory disorders for piglets. In addition, observations of the general health status were carried out by an external operator on each animal, once a week for sows and twice a week for piglets. This evaluation was based on a rating grid inspired by the Welfare Quality approach. All remarks relating to the health of the animals were recorded (pathology, severity, date, operator, veterinary intervention if necessary). For sows, individual urine test strips were used at the end of the pregnancy.

Statistical analyses

Data analysis by descriptive statistics was carried out under R version 3.3.1. The comparison of water consumption between pens according to their drinker type (traditional bowl drinker vs connected drinker) was carried out using a non-parametric test (Kruskal-Wallis).

Results

All the results related only to animals which were observed as being healthy. Data for sick animals were deleted from the database: (i) for locomotor, digestive or respiratory disorders, we kept the animal in the database but deleted all the data around the day concerned (ii) for urinary disorders; we deleted all the data for the animal.

Weaned piglets

At the end of the trial, data for 95 animals (from 114) were retained. On 22 days, the average water consumption did not differ significantly according to the drinking equipment (traditional bowl drinker vs connected drinker). Therefore, the automatic system did not seem to interfere with piglets' access to the drinker. The daily individual water consumption by piglets is, as an average for all animals, 10.7% of the body weight in kilograms (BW). Table 1 shows great inter-individual variability since the coefficient of variation (CV) calculated from the average of the individual average values obtained per piglet is 33.6%. At the intra-individual scale, the daily consumption expressed per kilogram of BW is also very variable, the coefficient of variation of the individual measurements being on average 31.5% (± 9.9).

Table 1 : Mean and variability of the daily water consumption of weaned piglets

Scale	Parameters	Values
Inter-individual	Mean, l/kg of body weight (BW)	0.104
	Standard deviation	0.035
	Coefficient of variation (CV), %	33.6
Intra-individual	Mean CV, %	31.5
	Standard deviation of CV	9.9

With the connected drinker, it was possible to track the daily water consumption of each piglet over several days. As an example, Figure 5 shows the individual consumption profiles of three piglets compared to the average profile obtained from 95 piglets.

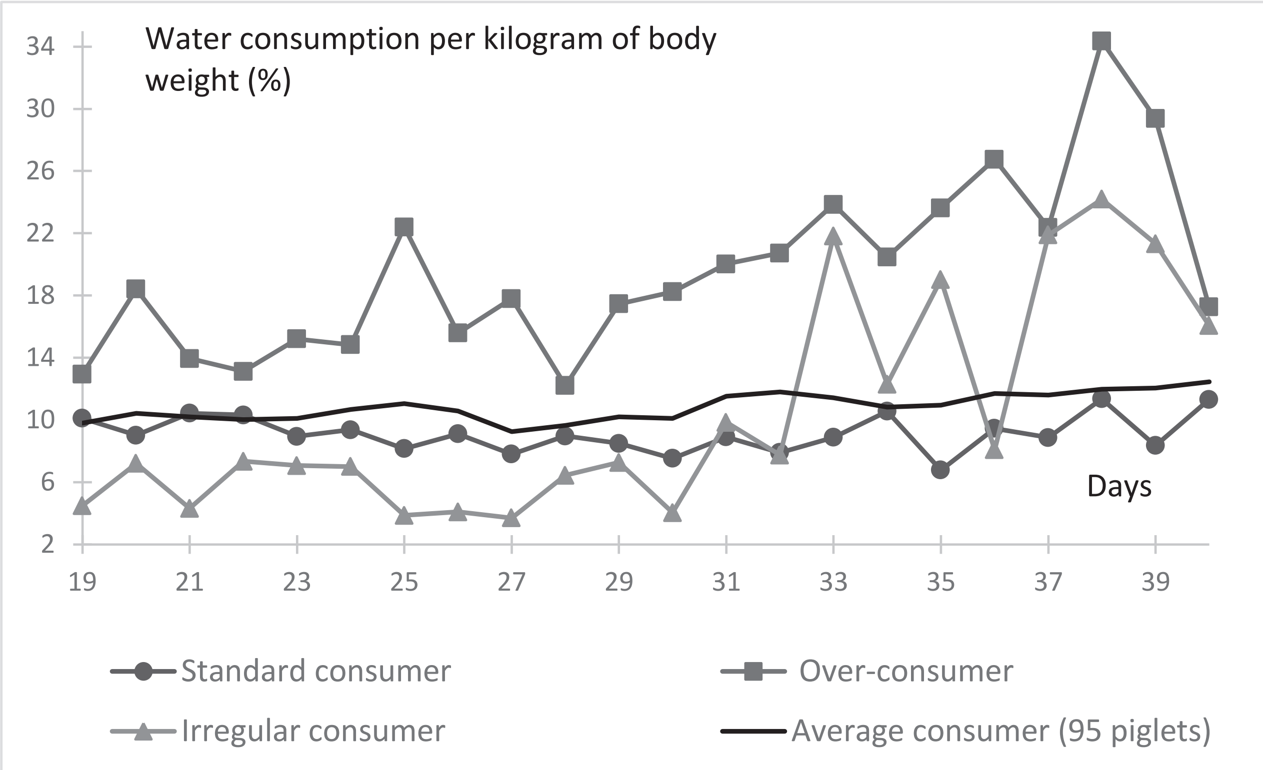


Figure 5: Contrasted examples of drinking behaviour of weaned piglets

- The profile named "Standard Consumer" matches with a piglet consuming a quantity of water between 7 and 11% of BW. Its profile is regular and relatively close to the consumption profile of the average piglet.
- The profile named "Irregular Consumer" matches with a piglet whose consumption of water from one day to the next can be very different (variation of 13.8 % of BW between the 36th (8.1% BW) and 37th day (21.9% BW)).
- The profile named "Over-consumer" corresponds to consumption which is higher than the average consumption of the average piglet. It varies from 13 to 34% of BW.

Most of the remaining 92 piglets did not have such specific and contrasting profiles as these three examples: they pass from one to the other over time, which is even more difficult to interpret and predict.

There is also great variability in the drinking behaviour of piglets. At each visit, the average amount of water consumed per piglet was 104 ml (SD 133). The number of visits to the drinker was around 27.2 (SD 12.3) per day.

Pregnant sows

At the end of the trial, the database held 4814 data records (1 data record is equivalent to the drinking behaviour of one sow on one day). We removed the data relating to sows with locomotor disorders and all the data for two sows: one with a urinary disorder and one because of aberrant data. Indeed, we identified an atypical sow whose average water consumption was 41.7 l / day, i.e. more than four times the water consumption of the average sow. This sow also represented 14.8% of the inter-individual variability in daily average water consumption.
The final database is composed of 81 sows and 3900 data records.

On average, sows weighed 252 kg and consumed 8.2 l of water per day, divided into: (i) 1.6 l consumed during the meal (water added in automatic feeder) and (ii) 6.6 l consumed spontaneously at connected drinkers.

For water consumption, Table 2 shows great variability on two levels. On the one hand, a very high inter-individual variability: the coefficient of variation (CV) calculated from the average of the average values obtained per sow is 50.0%. On the other hand, the intra-individual variability is also significant: the average individual CV for daily water consumption is 37.9% ± 10.2.

Table 2 : Mean and variability of the daily water consumption of pregnant sows

Scale	Parameter	Value
Inter-individual	Mean, ml/kg of body weight (BW)	33.2
	Standard deviation	16.5
	Coefficient of variation (CV), %	50.0
Intra-individual	Mean CV %	37.9
	Standard deviation of CV, %	10.2

As shown in Figure 6, the litter rank of sows was significantly linked to water consumption. The drinking behaviour of primiparous sows was completely different. Their water consumption was 49.2 ml/kg BW (± 46.9). Consumption by older sows (litter rank higher than 6) was lower than the first group at around 18.9 ml/kg BW. This concerned only a small percentage of the population (8 sows out of 81) so this result is subject to some reservations. Sows with a litter rank of 0, 2, 4 and 5 seemed to have the same water consumption at around 34.0 ml/kg BW.

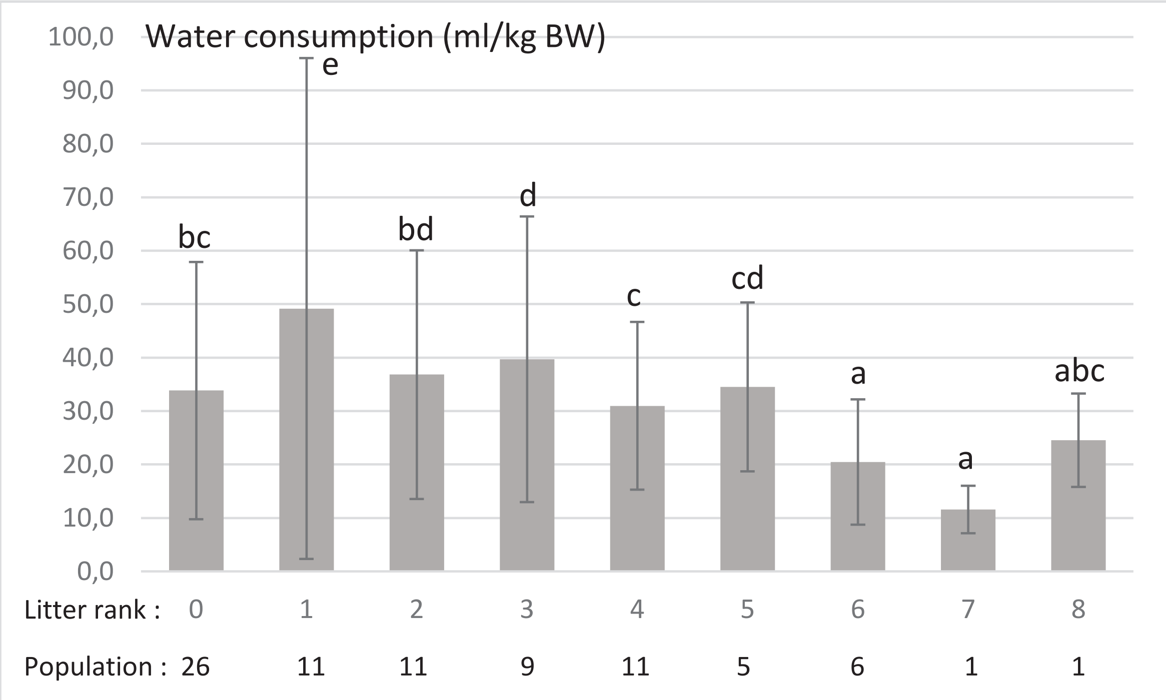


Figure 6: Water consumption and litter rank of pregnant sows.

The batch effect is correlated with the stage of gestation and there were significant differences. Sows at the start of the gestation (from the 28th to the 85th days of gestation) had a water consumption of 34.9 ml/kg BW. Sows in the middle of gestation (from 41 to 98 days) consumed around 45.0 ml/kg BW. Finally, sows at the end of gestation (from 62 to 110 days) consumed around 25.8 ml/kg BW.

These differences are not due solely to the litter rank of sows in each batch because we found the same type of results when we studied the interaction between batch and litter rank, and it was also significant.

Throughout the trial, the daily mean temperature of the pen remained at around 22.0°C (±1). Only one day was hotter, with a mean temperature of 26.9°C. The temperature had no effect on water consumption.

There was also no statistical link between water distributed through the feeding system and water consumption, probably because the main water consumption is through the bowl drinkers.

Discussion

The water consumption observed in weaned piglets (around 10% of BW) is very close to data already presented in the bibliography (Ward and McKague, 2007).

We did not observe an effect of the ambient air temperature, but piglets remained in their thermal comfort zone throughout the trial (between 24°C and 28°C).

Among the sows we also found that ambient air temperature had no effect on water consumption. It will probably be easier to show this effect in the month of July or August.

The global water consumption of sows was relatively close to the results presented by Klopfenstein *et al.* (1996) who found an average water daily consumption of between 5 and 9 litres per sow (dry feed and individual trough). Cerneau *et al.* (1997) reported an individual daily water consumption of 20 litres/sow (group of four animals with liquid feed distribution). With liquid feed distribution, water consumption is generally higher than in dry systems because most of the water intake is determined by the dilution rate.

Kruse *et al.* (2011) showed, with a connected drinker equivalent to ours, a link between water consumption, litter rank of sows and day of gestation. They worked with water consumption and not with water consumption divided by body weight. Nulliparous sows had the lowest consumption (around 12 litres/day) and multiparous the highest (around 22 litres/day). This result is probably due to the difference in weight between sows (around 160 kg for nulliparous and 270 kg for multiparous). Working with water consumption divided by body weight, we obtained less contrasted results and the water consumption per kilogram of BW seems to be lower for multiparous than for nulliparous sows. Kruse *et al.* did not find atypical results for primiparous sows, in contrast to this study where their drinking behaviour was very variable.

Kruse *et al.* showed an increase in water intake during the gestation which was related to weight gain of the sows. If this weight gain is taken into account, water intake per kilogram of BW seems to increase from the beginning to the middle of the gestation and then to decrease.

In the future, it would be interesting to measure water wastage in order to better understand the water consumption of a few sows and interpret this data in relation to ambient air temperature or behavioural disorders.

It could also be useful to study litter size in order to understand some of the variability in sows' water consumption. We can suppose that the larger the litter size, the higher the physiological water intake of sows.

Conclusion

There is significant inter and intra-individual variability in water consumption by healthy weaned piglets and pregnant sows, so it seems appropriate to work at an individual scale in order to study the link between drinking behaviour and the detection of pathologies. The connected drinker could therefore be an interesting means of achieving this. The next step is to use this data on water consumption of healthy pigs as a reference to understand and interpret variations when pigs begin to be sick. The final goal is to create a tool which is capable of generating relevant alerts in real time in connection with potential early deterioration in the health status of piglets or sows (diarrhoea, hyperthermia, lameness, etc..) or with problems in the drinking system (water leakage, obstruction). The huge variability observed is one of the main issues, so we will probably need to combine water consumption with other data from automatic systems or sensors (automatic feeder, automatic weighing station, accelerometers, etc.) in order to develop an efficient animal health alert system. Other studies are already in progress in this area and could create new opportunities for monitoring animal health status.

Funding and acknowledgement

The data were obtained during a research programme funded by CASDAR for the sows and by FAM for the piglets. The authors acknowledge D. Pilorget, K. Rocher, A. Debroise, R. Richard, D. Loiseau and P. Rocher for monitoring the trials, G. Melot for his contribution to the development of the database and Asserva for the technical support.

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