Water – an important key to succeed with pigs

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Abstract

There is limited knowledge about the amount of water needed by modern, highly productive sows. Modern sows are expected to require a lot of drinking water. This is largely due to selection for high meat percentage in finisher pigs, resulting in a high water content in the body. Modern sows also produce an average of 15 kg of milk daily during lactation when nursing 14 piglets. Some herds are already experimenting with sows nursing 18 piglets, which further increases the amount of water required by sows. Monitoring the amount of water used by lactating sows can help predict problems before they become visible to the naked eye, enabling farmers to intervene early and rectify these problems.

Keywords: Water, water usage, sow, temperature, hyper-prolific sows

Background

Water is essential for almost every process in the body. Sow milk consists of approximately 80% water (Jensen *et al.* 2015). About 50% of the body of a sow is made up of water (Pedersen *et al*. 2016; Pedersen *et al*. 2019; Strathe et al. 2020). This means that losing as little as 10% of its water content can be fatal for a lactating sow (Maynard *et al.* 1979). This is due to the essential role of water (e.g. the passage of feed through the gastrointestinal tract, digestion of the feed, utilisation of nutrients, discard of toxins, electrolyte balance and organ function). The sow's requirement for water is primarily based on its body weight, feed intake and physiological state (Jensen *et al.* 2015; Mroz *et al.* 1995). These factors are often determined by management, such as feeding strategy and housing (Paitience 2012).

In some genetic breeds, sows have become large, lean, and produce large litters (Strathe et al. 2020). Lean meat percentage is directly correlated with the amount of water in the body. For every kg of protein retained in the body, four kg of water is retained (Noblet & Etienne 1987; Rozeboom et al. 1994). Hence, modern sows have to retain more water to retain and mobilise protein.

Sow use less water close to farrowing (Udupi 2014), likewise, sick and stressed finisher pigs use less water than healthy pigs (Dominak *et al.* 2019a; Dominak *et al.* 2019b; Jensen *et al.* 2017). This suggests that water usage could be used as an indicator of stress and illness in sows. It could also be used as a proxy for milk yield, given that sow milk consists of about 80% water.

This article is based on a literature review and a pilot study. The aim was to determine the water requirement of highly productive sows and the physiological and environmental factors influencing their water requirements.

Literature review

Water requirement, water intake, and water usage.

Water requirement is the amount of water the sow needs to function properly. A sow's water requirement depends on its body weight, physiological state, and temperature (Mroz et al. 1995). Water intake is the amount of water the sow drinks. This can be challenging to estimate because water is wasted by the sow while drinking or during water play. Water usage is the total amount of water the sow uses: the amount she drinks and wastes. Up to one-third of water usage in finisher pig herds is water wasted (Bird 2001; Little *et al.* 2022).

Water usage of sows increases towards the end of gestation, decreases at farrowing, and then, increases again (Fraser & Phillips, 1989; Malmkvist et al. 2012). A recent study found that water usage increased from 15 L to 40 L per day from days 1 to 16 of lactation and remained at 40 L after day 16 (Kruse et al. 2011a). This means that the sows had an average water usage of 27.5 L per day. Kruse et al. 2011a also found that sows in their second parity used more water than sows in any other parity. This may be explained by increased feed consumption driven by higher milk production of sows in their second parity.

Water usage of sows in gestation follows a specific pattern over a 24-hour period (Aulodist et al. 2000). It peaks around feeding. No pattern was detected in lactating sows. Their water usage was distributed throughout the 24-hour period. This reflected milk letdown, which occurs every 40-50 minutes.

Impact of feed – including fibre and protein content in feed

Lactating sows' water requirements and consumption are often put in relation to their feed consumption. The recommendation is that for every kg of feed consumed, the sow should drink 4-5 L of water. Studies have shown that the sow's water consumption in relation to feed changes from 6–7 L of water per kg of feed to 3–5 L of water per kg of feed within the first week of lactation (Kruse et al. 2011a; Peng et al. 2007).

The feeding strategy as well as the feed composition have been shown to affect sows' water usage, such as fibre content. A study has found that sows fed a diet with an average of 9% fibre, drank 9.6 L more a day, compared to sows fed a diet with an average fibre content of 3.8%, five days prior to farrowing until five days after farrowing. The difference in water requirements based on soluble vs. insoluble fibres were not investigated, but one may think that this would also have an effect.

Besides fibre content, protein content of a diet has also been shown to affect water usage. Huber *et al.* (2015) have shown that sows had a higher urine production on day 3 – 7 (7.2 kg/day vs 12 kg/day) in lactation, as well as day 14 – 18 (7.8 kg/day vs 10.3 kg/day), when the protein content of the feed increased from 13.2% to 15.7%. Pfeiffer *et al.* (1995) also showed that finisher pigs' water consumption increased 26% in relation to an increase in the protein content of their diet, from 13.2% to 15.7%. Moreover, the study showed that the pigs' urine production increased by 55%. This is due to the excess protein and amino acids being converted to urea, which is excreted through the kidneys via urine. This excretion is

dependent on water. Thus, feed compositions with too high content of protein, or wrong composition of amino acids, will result in an increased water requirement.

Besides feed composition, feeding strategy also affects the water consumption, such as the water content of the feed, dry feed vs liquid feed, as well as restricted vs ad libitum feeding.

Supplying water
Pigs' water consumption has proved to be correlated with the method of supply, as well as the speed at which the water flows and placement of the water trough (Mroz et al. 1995). Older studies have shown that sows that drank from a bowl or trough with water surface drank more (13.6 L/day and 14.1 L/day) compared to drinking nipples (12,4 L/day) and pipes (10,8 L/day) (Cited by Fraser et al. 1990; Friend 1971; Riley 1978; Diblik 1986). SEGES Innovation's recommendations from 2010 is that water valves supply at least 4 L/min.

Besides Danish legislation stating that water should be available at all times for sows, there is no specific law or recommendation stating how water should be supplied. Older studies have shown that sows that were offered water in their feed trough prior to feeding, in addition to their actual water supply, caused an increase in water usage (Andersen 1985; Sørensen & Smidth 1993).

Ambient temperature
The water requirement and water usage of sows increases with ambient temperature. Black *et al.* (1993) found that the optimal temperature for food intake, milk yield and reproduction was between 12-22℃.

Sows are unable to cool themselves by sweating. When a sow's body temperature exceeds the normal temperature (Sipos et al., 2013), sows increase their water usage to cool their body temperatures (Linden 2014). Schiavon and Emmans (2000) found that finisher pigs' water usage increased by 0.12 L/day for every degree increased in ambient temperature. Quiniou *et al.*(2000) found that it increased by 0.16 L/day for lactating sows, while Phillips *et al.* (1990) found that it increased by 0.25 L/day for sows. These increases can be substantial for pig production. For example, temperature shifts from 18 to 28℃ would increase water usage by 1.6–2.5 L per day per sow.

Considering herds having several thousands of pigs, increase in water usage, when increasing ambient temperatures, results in large increases of total water usage in the herds, which the water supply needs to be sized to accommodate.

Water temperature
The water temperature affects the consumption. One study found that pigs water consumption reduced with 37%, when the temperature of the water increased from 11℃ to 30℃ (Vajrabukka *et al.* 1987).

The Danish recommendations is 12℃ from the faucet (Retsinformation: BEK nr. 1449 from 11/12/2007).

Jeon *et al.* (2006) also found that lactating sows drank and ate more, when the temperature of the water was 10℃ or 15℃, compared to water with a temperature of 22℃.

Water quality
The sow's water consumption depends on the quality of water. In Denmark, the water quality for animals is based on three factors: physical, chemical, and microbial properties (Danish Veterinary and Food Administration 2022).

Health status
Almond (1995) found that sick pigs had a higher water requirement than healthy pigs. E.g diarrhea is associated with large fluid losses, which is often the primary problem for especially piglets and weaner pigs. Kaiser *et al.* (2020) showed that in average of 35% of sows had post farrowing fever, however, it is likely to vary between herds.

A rule of thumb for humans is that for each degree the body temperature increases, the water requirements increase by 10-15% (Kristoffersen *et al.* 2006). Considering this, one could expect the water requirement and consumption in sows with fever would increase, due to the increase in body temperature. Despite this, there is often a decrease in water consumption in sick pigs. This is supported by Brumm (2006) which reported that farmers and veterinarians experience a decrease in water usage in sick pigs, and if the water usage decreased in three consecutive days or decreased by more than 30%, it could indicate health problems.

Drinking water should be examined in detail as pathogene microorganisms can cause outbreak of diseases (Patience, 2013).

Thus, it is possible that deviations from the normal drinking pattern of a pig can be used to predict disease. This was tested by Kruse *et al.* (2011b), who analysed the variation in drinking patterns in sick and healthy sows in the farrowing section, in order to identify sick sows. However, because the sensitivity varied from 34% to 83%, and the specificity varied from 32% to 93%, they were not able to differentiate between healthy and sick animals based on drinking patterns.

Pilot study
Water usage by lactating sows was evaluated in a pilot study. Data was collected from two farms, where one herd fed the sows dry feed (DF), and the other herd fed the sows liquid feed (LF). The feeding strategies of the two herds affected water usage because the sows from the LF-herd consumed water through their feed. In both herds, the sows were fed three times a day. Parity, number of liveborn piglets, number of stillborn piglets, number of piglets dying after farrowing, and the number of weaned piglets were registered. The DF-farm had approximately 480-500 sows per year. There were on average between 21-24 farrowings a week. There were 1,100 sows per year on the LF-farm. They had on average 40-60 farrowings a week.

Waterflow in each farrowing crate was measured by flowmeters (Badger Meter Flowmeter Vision 2006 4F44 1-10 LPM).

Water usage prior to farrowing
As found in the literature study, the pilot study showed that sows from the DF-herd had a higher daily water usage compared to sows from the LF-herd with the average daily water usage being 17 L/d for DF-sows and 12 L/day for LF-sows. This is likely due to a significant part of the LF-sows daily water requirements being covered by the water content in the feed.

Water usage in the lactating period
In the first three consecutive weeks after farrowing, the DF-sows had an average water usage of 20, 25, 29 L/d respectively, whereas the LF-sows had a relatively constant water usage of 11 L/d. But the constant water usage by the LF-sows is most likely due to an

increase in feed allocated for the sows throughout the lactation, and therefore, an increase in the amount of water consumed through the feed (Figure 1).

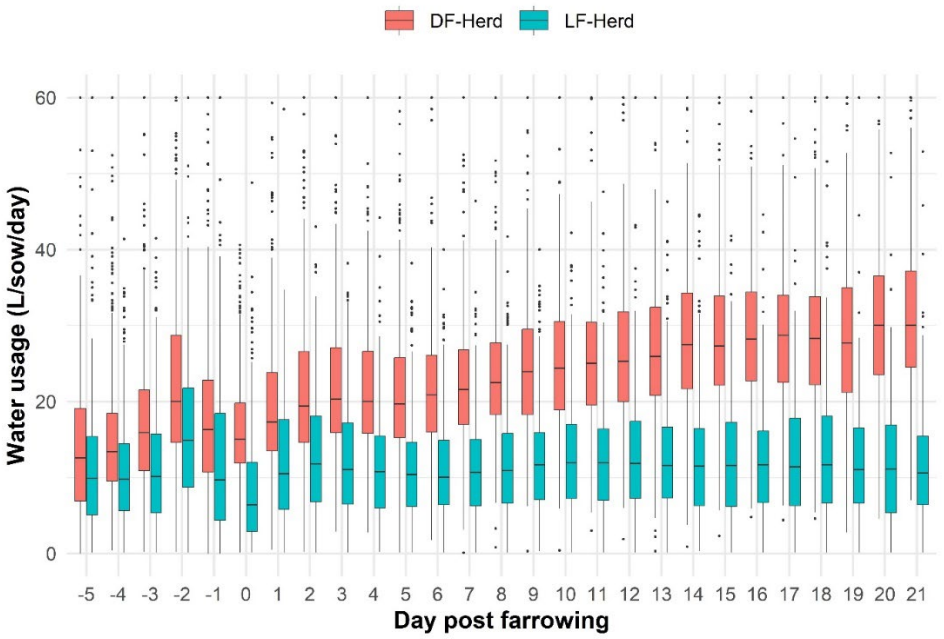

Figure 1 – Daily water usage (L/sow/day) for sows from 5 days prior to farrowing up until day 21 in lactation. DF-Herd (red) and LF-Herd (blue).

Water breaks and farrowing

As mentioned in the literature review, previous studies have shown that in the last two to four hours prior to farrowing, and during farrowing, the sows are very inactive. This was supported by the data from the pilot study, where the majority of the sows, from both herds, had water breaks in connection with farrowing. This can be seen as plateaus in Figure 2, when looking at the accumulated water usage for specific sows (Sow 5111-5170).

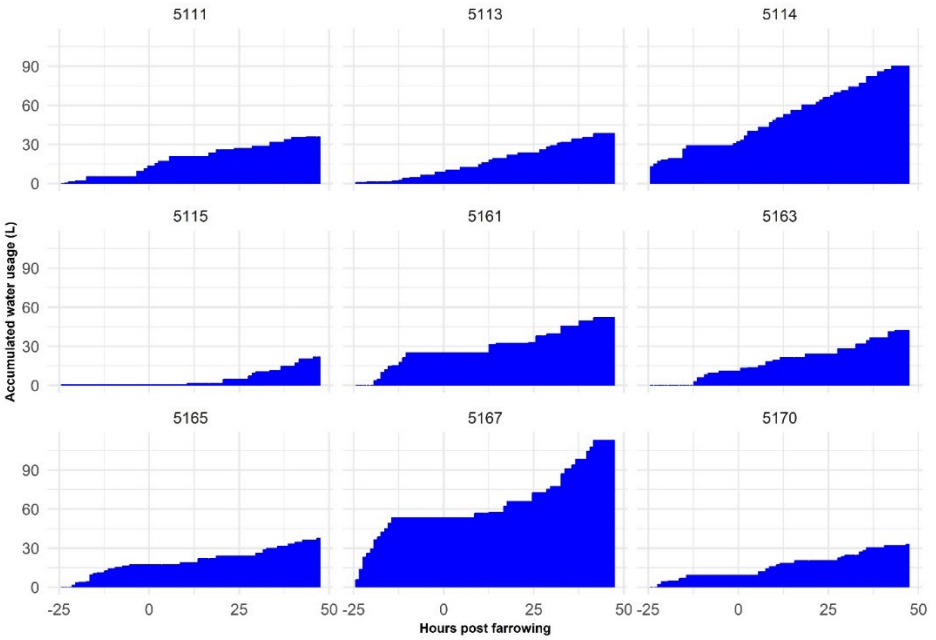

Figure 2 – Examples on registered total accumulated water usage for nine individual sows from the DF-herd. Drinking patterns and water breaks in the 24-hour period pre-farrowing (-24 to 0 hour), the day of farrowing (0-24 hour) and the 24-hour period post day of farrowing (24-48 hour).

The breaks in water usage for the DF-sows, proved to be able to foresee the farrowings and can be used as a notification to turn on the heat lamp in the covered creep area, instead of turning on all heat lamps in the section on a fixed day of the week, and thus, save energy.

Water usage and early piglet mortality
The pilot study also examined the data in relation to the duration of breaks in the water usage in correlation with the number of stillborns. In both herds, there was a large variation amongst sows in both the duration of water breaks and number of stillborn piglets per litter. Although in the DF-herd, there was an indication that sows with no stillborns had shorter water breaks (hours/day) on the day of farrowing, meaning that the sows drank more often, compared to sows with one or multiple stillborns. This indication was not seen in the LF-herd, which could be due to the sows receiving water through the feed.

There was no indication that the duration of the water breaks on the day of farrowing was correlated with the number of piglets dying within the first four days after farrowing, in either of the herds.

Water usage and treatment
Besides looking at the piglet's survival rate, the pilot study also examined the water usage in relation to treatments of the DF-sows with antibiotics. Sows were primarily treated close to or on the day of farrowing.

There was an indication that sows treated with antibiotics drank fewer times a day, as well as having a smaller water usage on the last two days prior to farrowing, compared to sows that were not treated. It is possible that the sows were sick and therefore drinking less before they were treated but without their sickness being visible to the naked eye.

Water usage and numbers weaned
Another relevant correlation that was analysed was the correlation between water usage and number of weaned piglets in the litter.

In the DF-herd, there was no correlation between water usage and number of weaned piglets, since the sows were similar in their water usage regardless of the amount of piglets they weaned. On the other hand, there were indications in the LF-herd that the sows with the highest daily water usage weaned more piglets, compared to sows with lower water usage.

Water usage and outdoor temperatures
The analysis also showed that the water usage was correlated with temperatures and seasons. Even though Denmark has a mild climate, it was evident that the water usage increased, in both herds, on days with temperatures above 10 °C, compared to colder days.

The increased water usage could both be explained by an increase in water consumption, as well as an increase in waste of water through play. The increase in water usage was larger in the LF-herd compared to the DF-herd. However, attention should be drawn to the fact that there was limited data from the summer-period in the LF-herd.

Table 1 Water usage (l/sow) day -4, 0, +4, +8, +12 and +16 compared to the seasons; summer; spring/autumn (change) and winter for the DF- and LF-herd, respectively (median and (25 and 75 %)).

	DF-Herd						LF-Herd					
Season	Summer[1]		Change[2]		Winter[3]		Summer[1]		Change[2]		Winter[3]	
Days related to farrowing	N[4]	Water Usage (L/sow/day)	N[4]	Water Usage (L/sow/day)	N[4]	Water Usage (L/sow/day)	N[4]	Water Usage (L/sow/day)	N[4]	Water Usage (L/sow/day)	N[4]	Water Usage (L/sow/day)
-4	50	14 (7-18)	105	14 (10-21)	313	13 (10-18)	9	20 (15-28)	69	11 (6-17)	273	9 (5-14)
0	63	17 (13-22)	134	15 (12-19)	353	15 (12-20)	17	10 (7-13)	76	5 (1-14)	293	6 (3-11)
4	61	20 (16-27)	138	21 (16-27)	369	20 (16-26)	18	10 (5-19)	68	11 (6-14)	280	11 (6-16)
8	53	23 (19-26)	102	23 (19-29)	273	22 (18-28)	11	12 (8-18)	53	10 (5-15)	229	11 (7-16)
12	42	27 (19-32)	99	25 (19-32)	274	25 (20-32)	9	15 (12-18)	51	10 (7-17)	212	12 (7-17)
16	40	23 (19-35)	101	30 (24-35)	253	28 (23-34)	8	13 (12-21)	53	11 (7-16)	163	12 (6-16)

1 Summer: Daytime temperatures constantly being over 10°C

2 Changet: Daytime temperatures changing over/under 10°C

3 Winter: Daytime temperatures constantly under 10°C

4 Parity

Conclusion - Litterature review and pilotstudy

The results from the pilot study were in accordance with results found in the literature review.

The pilot study showed that the water usage decreased in both the DF- and LF-herd prior to farrowing. The DF-herd showed an increase in water usage from farrowing up until day 21 of lactation, where the LF-herd had a stable water usage though lactation. This difference was due to the increase in feeding levels in the LF-herd, thus, an increase in water supplied through the feed.

The DF-herd had an average water usage of 17 L/day on the first day of lactation, whereas on day 18 it had increased to 28 L/day. These results are contradictory to the older studies presented in the literature study. This is expected to be linked to the modern sow producing more piglets, having an increased feed consumption as well as increased milk yield. This is also supported by third and fourth parity sows having a higher water usage than first and second parity sows. This is due to an increased feed consumption as well as milk yield.

In the DF-herd, there was an indication that sows with no stillborns had shorter water breaks, compared to sows with multiple stillborns. There was no difference in the water usage in correlation to the number of weaned piglets in the DF-herd, whereas there were indications that the sows in the LF-herd with the highest daily water usage weaned more piglets than sows with a lower water usage.

Sows in the DF-herd which had been treated with antibiotics showed indications of a reduced water usage as well as drinking fewer times a day, compared to non-treated sows. This could be explained by the fact that the sows treated were sick, and therefore, more immobile, and not likely to stand up to drink as often.

The results from the pilot study also showed that the water usage, in both herds, increased on days with a temperature over 10 ℃, compared to colder days. The increase in water usage, due to temperature increases, was higher in the LF-herd than the DF-herd. This could be due to the sows eating less on hot days, and therefore consuming less water through their feed, why they would compensate by drinking more. The general increase in both herds could also be due to waterplay rather than an increase in water consumption.

Perspectives

Despite water being an essential part of almost every process in the body, water receives limited attention in both research activities and daily management of hyper prolific sows, despite modern sows having an increased water requirement due to an increased milk yield. Some herds, furthermore, are experimenting with having 14+ piglets per sow, which, compared to 14 piglets, would require more from the sow.

It is possible that an increase in water consumption can result in an increase in milk yield, which can increase piglet growth and reduce mortality. The question is: how do we ensure sufficient water consumption so that the sow can utilise the full potential of their milk yield?

Besides increasing piglet survival, the use of water monitoring could also be used as indicators to predict farrowings and for how long the sow has been farrowing (not standing up and drinking). In addition, monitoring water usage can be used as an indicator for feed consumption and milk yield. Through monitoring of the water usage, the pig producers can identify deviations from the sows' normal drinking patterns, which can be used as indicators for reduced health or sickness.

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