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Influence of the use of nurse sows on their lifetime performance

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Abstract: Using nurse sows is a common practice for intensive pig farming because large numbers of piglets per litter result from intensive breeding. This aim of this study was to compare reproductive parameters of nurse sows and non-nurse sows in relation to subsequent reproductive performance. The study evaluated 463 breeding sows that produced at least one litter. The sows were divided into two groups: non-nurse sows (350 sows) and nurse sows (113 sows) at their first farrowing. The average length of first lactation was 35.12 days for nurse sows and 29.79 days for non-nurse sows. At first parity, nurse sows weaned 5.18% more piglets than did non-nurse sows ($P < 0.05$). At second parity, nurse sows had 2.25% more live born piglets than did non-nurse sows. Nurse sows also had 9.59% more total live born piglets and they were removed from the breeding herd later (on average by 67.1 days) than were non-nurse sows. In conclusion, using sows as nurse sows in their first lactations provides a good solution when there are large numbers of piglets per litter, and this practice has no negative effect on sows' subsequent reproductive performance.

Keywords: lactating sow; farrowing; litter size; piglet; reproduction; wean

Maintaining reproduction at high levels is a crucial aspect of modern pork production (Rothschild 1996). The primary indicator of success in pig breeding is the number of piglets born per sow per year. A result of successful breeding programmes today is that the numbers of piglets per litter can exceed the numbers of teats per sow (Schmitt et al. 2018). This phenomenon can be related to the breeds that are commonly used in hybridisation programmes. Bobcek et al. (2003) reported that the number of live-born piglets of Large White was increasing, and Large White is today commonly used on most intensively managed pig farms. The average number of teats per sow is 14, and in the Czech Republic on average 17.8 piglets were born per litter per sow during 2017 (CZSO 2018). It is apparent that large numbers of piglets in litters can be maintained only when sows exhibit excellent milkiness. In any case, it should be noted that high numbers of piglets reduce the amount of milk available to each of them (Cabrera et al. 2010). A common practice for successfully rearing large numbers of piglets per litter is to use nurse sows. Nurse sows increase the survival of so-called "surplus" piglets. Bruun et al. (2016) defined a nurse sow as the sow that weans its own litter after a minimum of 21 days of lac-

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tation (Regulation 2008/120/EC) and then weans another litter of surplus piglets from another sow at minimally 21 days of lactation. Alvasen et al. (2017) reported that nurse sows were sows weaning their piglets while within one group of sows and subsequently were transferred to another group of sows located in another farrowing house. Here, sows received surplus piglets from other sows and weaned them at minimally 21 days of lactation. Bruun et al. (2016) found that nurse sows can be developed from suckling sows in one or two steps. In one step means that a nurse sow weans its own piglets at least at 21 days of lactation and then receives surplus newborn piglets from another sow and weans them at minimally 21 days of lactation. In two steps means that piglets of sow X are given at the age of 4–8 days to sow Y and sow X then receives newborn piglets from sow Z that are surplus within Z's own litter. Sow X weans them after a minimum of 21 days of lactation. It has been found that older piglets are better accepted by the nurse sows than are the newborn piglets. The result of nurse sows' weaning two litters each is prolonged lactation. Prolonged lactation in nurse sows can have a negative effect on animal welfare, because it can cause a loss of body reserves due to the high milk production (Koketsu et al. 2017). This was confirmed by Alvasen et al. (2017), who reported that prolonged lactation worsened nurse sows' body condition while leading also to teat damage and leg ulcers, which negatively affected subsequent litter size. Prolonged lactation can cause a longer weaning-to-oestrus interval as well (Koketsu et al. 2017). Lactation length together with the weaning-to-oestrus interval affects subsequent litter size (Dewey et al. 1994), because of histological changes in the mammary tissue. Histological evaluation of the mammary gland showed a modest number of changes, although these changes were not differentiated between the groups of non-nurse sows and nurse sows (Rekiel et al. 2007). Bruun et al. (2016) also observed no differences between the groups in the same period when they became pregnant in the subsequent reproductive cycle. Morrow et al. (1992) observed that the number of piglets per litter was positively, but not linearly, associated with longer lactation length. According to Le Cozler et al. (1997), in the case of a very short lactation length, the size of subsequent litter was materially smaller. Another study showed that longer lactation positively influenced the number of live born piglets in the subsequent litter (Xue et al. 1993), and simultaneously that sows with longer lactations were culled later from the breeding herd (Xue et al. 1997). We hypothesised that prolonged first lactation in nurse sows has a negative effect on their subsequent litter size and lifetime performance due to the exhaustion of body reserves. The aim of this study was to compare subsequent reproductive parameters of nurse sows and non-nurse sows.

MATERIAL AND METHODS

In this study, 463 breeding sows from a farm with intensive pig farming were evaluated. The evaluated pig farm used sows of DanBred genetics (crossbreds of Landrace × Yorkshire). Sows were fed twice a day complete compound feed. Sows were selected for the study only after they had been removed from the breeding herd, because data on lifetime performance were then known. The sows were divided into two groups: non-nurse sows and nurse sows at their first lactation. 350 sows were assigned among the non-nurse sows and 113 sows were assigned into the second group. Sows with better body condition that were evaluated subjectively by keepers were selected as nurse sows. Nurse sows weaned their own litter at the age of 21 days. Then the nurse sows got surplus piglets from another sow at the age of 8 days. Until that time surplus piglets were fed in their own litter thanks to split suckling. Nurse sows weaned the second litter after 14 days. Non-nurse sows weaned their piglets at the age 28 days. It was necessary to calculate the lactation length of those sows that were used as nurse sows after weaning their own litters. Average lifetime performance was determined for all sows, as measured by the sums of all live born and still-born piglets divided in each case by the litter number after which the sow was removed from the breeding herd. The selected sows were included in the breeding herd at an average age of 187.13 days, were inseminated for the first time at an average age of 231.16 days, and in some cases they remained in the breeding herd as long as through the eighth farrowing. The sows were inseminated in natural oestrus. All those sows evaluated produced at least one litter. Every reproductive cycle for every sow was recorded into the system from the time of sow's inclusion in the breeding herd until its removal. Sows were removed from

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breeding after their two unsuccessful inseminations. Information was recorded about every insemination, farrowing, number of live born and still-born piglets and number of weaned piglets. Statistical evaluation was performed using the SAS statistical software (Statistical Analysis System, v9.4; SAS Institute, Cary, NC, USA). Analysis of variance and generalised linear models were used in evaluating the influence of individual effects (influence of using sows as nurse sows on their subsequent reproductive performance, influence of first litter size on lifetime performance of sows, and influence of sows' reproductive performance on sow longevity).

Subsequently, the following indicators were calculated and evaluated: least-squares means, standard deviations, standard errors of the means (SEM), and *P*-value (while setting statistical significance at $\alpha = 0.05$).

RESULTS AND DISCUSSION

Figure 1 contains information about the number of nurse sows and non-nurse sows at parity and their percentages. At the first lactation, 113 sows (24.41% of the total number) were used as nurse sows. For subsequent parities, the numbers of nurse sows decreased but their percentage increased. At the second lactation, 101 sows (26.79%) were used as nurse sows. At the third to the fifth lactations, the situation remained similar like at the second lactation. The percentage of nurse sows in the herd was growing up to the fifth parity and then began to decrease. The high percentage of nurse sows at parity eight (35.29%) could be due to rather a low number of the original sows generally remaining in the study groups at that point.

Table 1 shows the average reproductive performance of non-nurse sows and nurse sows at their first farrowings. There were no significant differences in the number of live born piglets between the two groups or in the mean number of stillborn piglets. Nurse sows had, however, the 15.79% higher mean number of stillborn piglets at first farrowing. Nurse sows weaned 5.18% more piglets ($P < 0.05$) from their own litters. More piglets weaned by nurse sows could be due to better condition score, better maternal characteristics, or good nutrition of sows and piglets. For example, Mei et al. (2019) observed that supplementing γ-aminobutyric acid to piglets' feed can improve the stress response of piglets and increase the number of weaned piglets. A selection criterion for becoming a nurse sow was the number of weaned piglets per sow from its own first litter (called here "litter A"). Nurse sows did not have less than 13 piglets of theirs own. Nurse sows weaned a mean of 13.23 piglets per first litter B (foster lit-

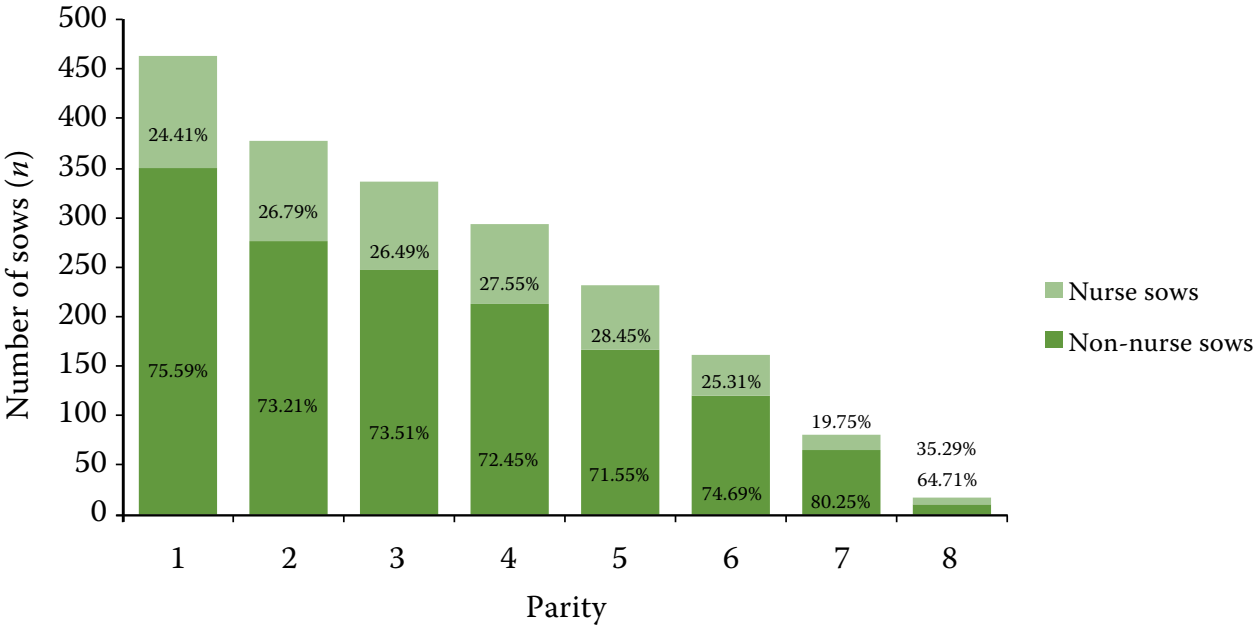

Figure 1. Number of nurse sows and non-nurse sows per individual litters

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Table 1. Reproductive performance of non-nurse sows and nurse sows at first farrowing

Trait	Non-nurse sows				Nurse sows				*P*-value
	mean	minimum	maximum	SEM	mean	minimum	maximum	SEM	
	reproductive performance at first litter				reproductive performance at first litter				
Number of sows (*n*)	350				113				
Live born piglets per first litter (*n*)	14.58	4	20	0.15	14.37	3	20	0.26	0.483
Still-born piglets per first litter (*n*)	0.16	0	3	0.03	0.19	0	4	0.05	0.634
Weaned piglets per first litter A (*n*)	12.56	0	16.0	0.11	13.21	13	16	0.20	0.005
Weaned piglets per first litter B (*n*)	–	–	–	–	13.23	9	16	–	–
Weaning-to-oestrus interval (days)	6.49	1	38	0.30	5.40	4	25	0.48	0.055
First lactation length (days)	29.79	2	46	0.31	35.12	10	45	0.55	0.001

Litter A = own weaned piglets; Litter B = weaned nurse piglets; SEM = standard error of the mean

ter). Therefore they weaned on average 26.44 piglets in total after the first farrowing. Nurse sows had the longer first lactation (on average by 5.33 days). Longer lactation duration is associated with better subsequent reproductive performance, and specifically with larger subsequent litter sizes (Xue et al. 1993). Hildago et al. (2014) found that the longer lactation of primiparous sows improves total piglets born and litter size at their subsequent farrowing. Extending the lactation length from 22 days to 25 days has been shown to provide better results in the litter size of sows at subsequent parity (Costa et al. 2004), and our study confirms this earlier finding. Sows used as nurse sows during their first lactations had a higher average number of live born piglets per second litter than did non-nurse sows. Nurse sows with prolonged lactation had the mean weaning-tooestrus interval shorter by 1.09 day, although this difference was not found to be statistically significant. The longer period for uterine involution accompanying the prolonged lactation might be beneficial, because uterine involution need not be completed yet in sows weaned at 21 days of lactation or less (Koketsu et al. 1999).

Table 2 describes the average reproductive performance of non-nurse sows and nurse sows at second parity. Greater loss of body reserves and reduction of backfat thickness can cause a lower number of live born piglets at subsequent parity and diminish lifetime performance. Koketsu et al. (2017) confirmed that prolonged lactation can cause nurse sows to lose too much of their body reserves due to high milk production. Lactation weight losses > 10% have a negative effect on subsequent reproductive performance (Thaker and Bilkei 2005). The body condition at weaning influences the subsequent litter size. Schenkel et al. (2010) reported that females weighing more than 178 kg, with backfat thickness ≥ 16 mm or with body fat ≥ 21% at weaning, had the larger second litters. On the other hand, Schmitt et al. (2018) found no differences between the two groups of

Table 2. Reproductive performance of non-nurse sows and nurse sows at second farrowing

Trait	Non-nurse sows				Nurse sows				*P*-value
	mean	minimum	maximum	SEM	mean	minimum	maximum	SEM	
	reproductive performance at second litter				reproductive performance at second litter				
Number of sows (*n*)	276				101				
Live born piglets per second litter (*n*)	16.04	0	23	0.20	16.41	8	25	0.32	0.330
Still-born piglets per second litter (*n*)	0.26	0	14	0.06	0.18	0	2	0.09	0.446
Weaned piglets per second litter (*n*)	12.21	0	16	0.17	11.89	0	15	0.28	0.325
Second lactation length (days)	28.61	0	51	0.44	28.70	0	46	0.72	0.911

SEM = standard error of the mean

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sows when comparing body condition and severity of lesions during lactation. No significant difference in the number of live born piglets per second litter was observed in the present study. Nevertheless, the nurse sows had 2.25% more live born piglets than did non-nurse sows, and this is consistent with the study by Koketsu et al. (2017), who found that nurse sows had more piglets born alive at subsequent parity than did non-nurse sows. Better reproductive performance of nurse sows in this study could be caused by a longer period of involution due to the prolonged previous lactation. According to Vernunft et al. (2018), the problems of decreasing piglet weights and placental lengths are related with increasing litter size and they could cause complications during farrowing. Due to their prolonged lactations, nurse sows have more time to regain strength for the subsequent reproductive cycle. There was no statistically significant difference between groups in the mean number of stillborn piglets per second litter, although this number was 30.77% lower for nurse sows. For non-nurse sows, the number of still-born piglets was higher by 38.46% than at the first farrowing. Koketsu et al. (1999) observed that lower numbers of stillborn piglets are born from the second to the fourth litters. In this case, the higher number of stillborn piglets of non-nurse sows could be caused by complications during farrowing, human error at farrowing time, or health problems of sows. In a study on genetic parameters for piglet losses, Wolf and Wolfova (2012) found that 2% of the total variance in piglet deaths prior to weaning "was caused by permanent environmental effects of the sow".

Table 3 documents the lifetime reproductive performance of non-nurse sows and nurse sows. There was no statistically significant difference in average age at first insemination between the two groups of sows. Differences between groups began to appear after the first farrowing. There was no statistically significant difference between the two groups in the mean number of lactations per lifetime, although the nurse sow group in fact had on average 0.41 (9.01%) more lactations. Bruun et al. (2016) reported that nurse sows' longer lactations have no influence and no negative effects on the subsequent reproductive performance and that nurse sows wean more piglets and have higher numbers of total piglets born at their subsequent parities. This statement corresponds with the results of this study. There was no statistical difference in the mean number of total live born piglets per litter. According to Le Cozler et al. (1997), the size of a subsequent litter is lower in the case of a very short lactation length. Another study shows that total number of piglets per sow per year and number of live born piglets per sow per year are not significantly associated with the lengths of sows' previous lactations (Xue et al. 1993). Some authors have also stated that higher numbers of litters correspond with higher numbers of stillborn piglets (Randall and Penny 1970; Leenhouwers et al. 1999; Koketsu et al. 2017). Simultaneously, there was no statistically significant difference in average numbers of total live born piglets. Nevertheless, nurse sows produced on average 7.04 (9.59%) more live born piglets during their lives. Serenius and Stalder (2004) reported that a higher number of weaned piglets in the first litter is a positive indicator

Table 3. Lifetime reproductive performance of non-nurse sows and nurse sows

Trait	Non-nurse sows				Nurse sows				*P*-value
	mean	minimum	maximum	SEM	mean	minimum	maximum	SEM	
	lifelong reproductive performance				lifelong reproductive performance				
Lactation (*n*)	4.14	1	8	0.12	4.55	1	8	0.21	0.083
Age at first insemination (days)	230.71	149	287	0.74	232.53	210	290	1.31	0.226
Live born piglets, total (*n*)	66.40	6	154	2.03	73.44	7	146	3.58	0.088
Live born piglets per litter (*n*)	15.57	6	21.6	0.13	15.67	7	20.3	0.22	0.698
Still-born piglets per litter (*n*)	0.30	0	7.5	0.03	0.27	0	1.8	0.05	0.571
Total weaned piglets per litter A	51.97	0	109	29.05	57.16	13	107	25.92	0,091
Total weaned piglets per litter B	–	–	–	–	19.58	9	52	–	–
Age at leaving herd (days)	867.20	359	1 474	17.09	934.27	376	1 482	30.08	0.053

Litter A = own weaned piglets; Litter B = weaned nurse piglets; SEM = standard error of the mean

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for sow longevity and lifetime performance. This statement corresponds with the results from this study. Nurse sows used as nurse sows in their first lactations were removed from the breeding herd 67.1 days later, although this difference was not statistically significant. The results of this study show that prolonging the lactation of nurse sows has no negative effect on their subsequent and lifetime performance. In this study, nurse sows had higher average number of piglets per litter and simultaneously better subsequent reproductive performance. This could reflect good farm management, good sow health, or longer period of uterine involution.

CONCLUSION

Sows used as nurse sows in their first lactations showed better lifetime reproductive performance than did non-nurse sows, had higher number of weaned piglets in the first litter, had indistinguishable or higher number of total live born piglets, and appear to have been removed somewhat later from the breeding herd than non-nurse sows. Prolonged lactation from using sows as nurse sows in their first lactation potentially appears to have a positive effect on the animals' subsequent and lifetime performance, and in any case it is an advantageous solution for addressing high numbers of piglets per litter. This can be a great benefit for intensive pig farming, because using sows as nurse sows at their first or later lactations enables piglets to survive that might not thrive among their littermates and the survival of these piglets is economically very important for farms.

Conflict of interest

The authors declare no conflict of interest.

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