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Sow behaviour, backfat loss and litter performance in first parity outdoor sows

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Abstract

This study is based on 40 first parity Yorkshire x Landrace sows kept outdoors. Sow behaviour was recorded on videotapes 4 days postpartum and direct-monitored 4 and 6 weeks postpartum. Statistical analyses were done with SAS PROC GLM and MIXED. Significant correlations were found between nursing frequencies at different occasions and also between nursing duration. Nursing frequency and duration decreased and percent nursings terminated by the sow increased through the lactation. Percent of time the sow was lying at 4 and 6 weeks were positively correlated. Percent of time spent outside the hut, unavailable for the piglets, and percent of time laying down, available for the piglets, had no significant correlation to nursing frequency at day 4. Litter size affected nursing duration day 4, indicating that pigs in large litters were nursed longer each time. Sow backfat loss from 2 weeks of lactation to weaning increased with litter size. Sows with high backfat loss week 2 to weaning laid down less and had shorter nursing duration than sows loosing little backfat. Percent consumed feed of norm during the first two weeks was correlated to piglet growth until weaning. In conclusion; sow nursing behaviour and sow activity are repeatable within lactation; litter size and backfat loss are related to nursing behaviour; sow appetite after farrowing is important for piglet growth and neither nursing behaviour nor sow backfat loss is significantly correlated to piglet growth when piglets are weaned at 7 weeks.

Introduction

In outdoor production, a large proportion of the responsibility for the piglets is shifted from the herd man to the sow, compared to indoor production. This puts high demands on sows' maternal ability, such as maternal behaviour, milk production, individual resource allocation etc. Thodberg *et* al. (2002) concluded that there is individual variation in maternal behaviour and that the environment has an impact on the development of the maternal behaviour. Nursing frequency influences piglet growth positively (Valros *et al.*, 2002). Changes in nursing behaviour during lactation suggest an ongoing weaning process through the whole lactation and Damm *et al.* (2003) propose that this gradual weaning process differ in different environments.

The breeds used in organic outdoor production are often the same breeds as used in conventional production, bred for high performance in a strict human-controlled environment. Framer *et al.* (2002) found differences in resource allocation and nursing behaviour between different pig breeds. Grandinson *et al.* (2005) found genetic variation in maternal behaviour and in sow backfat loss during lactation. Valros *et al.* (2003) showed that sow metabolism is correlated to nursing behaviour.

This study is a part of a project called 'Pigs suitable for organic production', in which we aim to answer the following questions: Are there genotype by environment interactions between organic and conventional pig production? Which traits characterize good sows in organic outdoor

production? The aim of the present study was to investigate how maternal behaviour, sow backfat loss and litter performance of the individual sow are related, in an outdoor environment.

Materials and methods

Animals and registration

40 Yorkshire x Landrace sows and their first litters were studied at the university's (SLU) research station Funbo-Lövsta. The gilts were born and raised outdoors, in the same environment as where they farrowed.

The gilts farrowed in single pastures (0.025ha) with farrowing huts (3.9 m^2), to which they were moved 5 days before expected farrowing day (mean 5.2, SD 1.6 days). Two weeks after farrowing (mean 13.8, SD 0.9 days) the sows were grouped into "nursing groups" with three or four families in each and moved to larger pastures (0.15 ha), where they stayed until weaning at 7 weeks (mean 48.7, SD 3.2 days). Each family pasture contained one hut (13.0 m^2) and one wind shed (11.0 m^2).

Sows were fed an "organic-like" feed containing 12.2 ME MJ/kg feed, 154.3 g cp/kg feed (122.6 g dcp, 7.5 g lys) and 89.1 % dm. The sows were fed individually during pregnancy and the first two weeks after farrowing according to a norm that was based on litter size. The sows were group fed *ad lib.* from 2 weeks after farrowing until weaning and had unlimited access to pasture. The piglets had access to sow feed but were not fed piglet feed.

Sow backfat was measured 5 days before expected farrowing, and at 2 and 7 weeks after farrowing by ultrasound. At the day of farrowing the numbers of piglets born were registered. Four days after farrowing, the piglets were tattooed with an individual number and weighted and male piglets were castrated. The piglets were also weighed and ear tagged (plastic ear tag) with an individual number 2 weeks after farrowing. The piglets were weighed again at weaning.

The behaviour and activities of sows and their litters were videotaped inside the farrowing hut on day 4 after farrowing, during 24 h. From these videotapes nursing duration, nursing frequency, nursing terminator (sow or piglets), milk letdown and sow lying duration was recorded manually with the program TASTX (Decker, 2003).

Sow behaviour were recorded by direct observation 4 and 6 weeks after farrowing (during one day between 9 am and 3 pm). Nursing duration, nursing frequency and nursing terminator were continuously observed during this 6 hour period and sow activity (active or lying) was scanned every 10 minutes.

The definition of a nursing event was: continuing for more than 60 seconds and including more than 50 % of the litter. If the sow rolled over, was lying on the belly or stood up when nursing, she was considered the terminator of nursing. If the piglets either fell asleep at the udder or more than 50% of the litter left the available udder, the piglets were considered to be the terminators of the nursing.

Statistical analyses

Handling of data and the statistical analyses were preformed using SAS software. The distribution of all variables was examined using SAS PROC UNIVARIATE (SAS, 2005). The variables not showing normal distribution were log transformed and checked for normality again. Variables not normal distributed even when transformed were instead classified into groups.

The fixed effects of litter size day 4 (classes: <9, 9-10, >10 piglets) and nursing group (including season and registration person in the behavioural studies) were analysed in GLM for each variable.

When litter size day 4 and nursing group had significant effects, they were included in the models for that variable as fixed effects.

Correlations were calculated between continuous variables that showed normal distribution. PROC GLM (SAS, 2005) was used when litter size day 4 and nursing group were included in the model, computing residual correlations. PROC CORR (SAS, 2005) was used to analyse Pearson correlations when neither litter size day 4 nor nursing group were included in the model. PROC FREQ (SAS, 2005) was used for chi-square tests. Variables divided into classes were included in the model as fixed effects and pair vice comparisons of least square means (LSM) was tested with t-test in PROC GLM (SAS, 2005).

Repeated measures of the same trait (day 4, week 4 and week 6) were analysed using PROC MIXED (SAS, 2005), REPEATED statement. The covariance matrix structure was chosen for each repeated variable according to fit statistic, AIC. Compound symmetry (CS) was chosen for nursing frequency and unstructured (UN) for nursing duration, percent of nursings terminated by the sow and lying percent.

One sow was excluded from the statistical analyses because she got only two piglets of which one died after birth and the other during the first 24 h after birth. Two sows were excluded from registrations later than week 2 after farrowing. One of them was culled because of an accident and the second was sick and moved indoors. The registrations from these two sows were only included for the first two weeks. In some cases there were missing values because of errors in backfat recordings or low quality of videotapes.

The statistical significances are presented as: $p>0.1 = ^{ns}$, $0.1>p>0.05 = ^{\dagger}$, $0.05>p>0.01 =*$, $0.01>p>0,001 = **$, $0.001>p = ***$.

Results

Piglet growth rate was higher week 2 to 7 after farrowing than 4 days to 2 weeks after farrowing. Sow feed intake day 0 to 14 after farrowing was lower than the recommended feed intake (table 1).

Table 1. Mean, standard deviation, min. and max. values of production traits

	Mean	**SD**	**Min.**	**Max.**	**N**
Total number of born/litter	11.1	2.7	5	16	39
Number stillborn/litter	0.1	0.4	0	2	39
Total number of dead/litter	2.2	1.8	0	7	37
Piglet growth 4d to 2w g/day	266	54	90	460	39
Sow backfat loss -5 d to 2w (mm)	-4	3	-15	10	37
Feed intake, % of norm d 0 to14	62	17	16	98	39
Piglet growth 2w to 7w g/day	339	54	224	467	37
Sow backfat loss 2w to7w (mm)	-3	3	-11	40	36

Nursing behaviour and activity

Nursing frequency and duration of nursing decreased and percent nursings terminated by the sow increased through lactation. The percent of time the sow laid down was higher during early lactation than during late lactation (table 2).

Table 2: Mean nursing behaviour and lying percent of time on day 4, week 4 and week 6 (LSM) Values on the same row with different subscripts are significantly different ($p < 0.05$)

	4d	**4w**	**6w**	**N**
Nursing frequency (/ h)	1.5^{a}	1.0^{b}	0.9^{c}	38
Nursing duration (min/nursing)	6.7^{a}	3.3^{b}	3.7^{b}	38

Percent of nursing terminated by the sow	30.4[a]	83.2[b]	90.0[c]	38
Percent lying	84.8[a]	40.2[b]	43.3[b]	38

Significant correlations between repeated measurements were found for nursing frequency, nursing duration and percent lying (table 3). A chi-square test showed a significant (***) positive relation between percent of nursings terminated by the sow week 4 and 6.

Table 3: Correlations between repeated measurements

	4d-4w		**4w-6w**	
	r	Sign.	r	Sign.
Nursing frequency	0.40	*	0.37	(†)
Nursing duration	-0.42	*	0.63	***
Percent lying	-0.08	ns	0.49	**

Number of positional changes during 24 h was negatively correlated to number of nursings (r=-0.48 *) and mean duration of nursings (r=-0.54*) on day 4. The correlation between time spent outdoors and number of nursings on day 4 was not significant (r=-0.17). Percent lying of observations tended to correlate to number of nursings (r= 0.35 (†)) and nursing duration (r=0.47 (†)) at week 4. These findings indicate that active sows, with many postural changes and low lying percent, gave fewer and shorter nursings than calmer sows. No significant correlation was found between sow nursing behaviour and sow activity at week 6.

Sow behaviour and litter performance

Sows with small litters tended to spend more time in the hut on day 4 (<9 piglets; 94%) compared to sows with average litter (9-10 piglets; 90%, p=0.06) and large litters (>10 piglets; 91%, p=0.23), but there was no difference in percent of time lying down in the hut.

Sows with large litters gave longer nursings and tended to give less unsuccessful nursing on day 4. Sows with large litters tended to give fewer nursings at week 4 and 6 (table 4). No significant relationships were found between litter size and percent nursings terminated by the sow or between sow behaviour and piglet growth.

Table 4. Mean nursing behaviours for sows with different litter sizes (LSM). Values on the same row with different superscripts are significantly different ($p < 0.05$)

	Litter size day 4		
	Small <9 N=12	Average 9-10 N=12	Large >10 N=16
Nursing frequency with milk letdown (/24 h) 4d	30.0	30.9	30.9
Nursing frequency without milk letdown (/24 h) 4d	7.3[a]	6.6[ab]	4.2[b]
Nursing duration (min/nursing) 4d	5.8[a]	6.5[a]	7.6[b]
Nursing frequency (/6 h) 4w	7.4[a]	6.2[ab]	5.3[b]
Nursing frequency (/6 h) 6w	5.3[ab]	5.8[a]	4.3[b]

Sow backfat loss, litter performance and sow behaviour

Sows with large litters lost more backfat week 2 to 7 after farrowing than sows with small litters (r = -0.30(†)). Few of the sows consumed feed according to their energy need during the first two weeks of lactation, and sows with large litters consumed a lower percent of their energy need than sows with small litters (r = -0.48**). Sows with higher feed intake during the first two weeks had a higher mean piglet growth rate (4d-2w: r = 0.37*, 2w-7w: r = 0.36 (†)). No significant associations were found between piglet growth and sow backfat loss or litter size. Sows that lost much backfat

week 2 to 7 seemed to give shorter nursings and were lying down less than sows that lost less backfat during this period (table 5).

Table 5. Relations between sow backfat loss and sow behaviour (LSM). Values on the same row with different superscripts are significantly different ($p < 0.05$)

	Sow backfat loss 2w to 7w (mm)		
	Low loss (-5)-0 N=12	Average loss (-8)-(-5) N=13	High loss (-13)-(-8) N=12
Nursing frequency (/6h), 4w	6.5	6.0	6.2
Nursing duration (min/nursing) 4w	4.1[a]	3.0[b]	3.0[b]
Percent lying of observations 4w	47.4[a]	37.6[ab]	32.2[b]
Nursing frequency (/6h) 6w	5.3	5.6	4.7
Nursing duration (min/nursing) 6w	5.0[a]	3.3[b]	3.0[b]
Percent lying of observations 6w	48.6[a]	40.1[ab]	37.7[b]

Discussion

The aim for organic piglet production outdoors is the same as for conventional piglet production, to wean as many and as heavy piglets as possible. The outdoor sow has a larger responsibility for her piglets than the indoor sow, thus the need for sows with good maternal ability is larger in outdoor piglet production. In this study, the aim was to describe how sow behaviour, litter performance and sow backfat loss are associated in first parity outdoor sows.

Valros *et al.* (2002) stated that sow nursing behaviour was repeatable within sow and lactation indoors on multiparity sows weaned at 5 weeks and this was in accordance with our observed correlations between repeated measures of nursing frequency, nursing duration, percent nursings terminated by the sow and percent lying at 4 and 6 weeks. Nursing frequency was also repeatable between day 4 and week 4. Since the variables measured several times are repeatable within sow we know that we measure an individual behaviour. Nursing frequency, nursing duration and percent lying down decreased and percent nursings terminated by the sow increased over time within lactation, indicating an ongoing weaning process through the whole lactation, in accordance to Valros *et al*. (2002).

Sows with large litters had longer nursings and lost more backfat than sows with small litters. This is probably due to the high milk production needed for large litters. Sows with large litters showed problems eating enough compared to their needs. Recourse allocation from backfat to milk and restricted nursing frequency or nursing duration are means to reach equilibrium between the needs of the sow and the needs of the piglets. This was reflected by the finding that sows loosing much fat had shorter nursings and lied down less. Thus they were less available for the piglets during the later part of the lactation, than sows loosing little fat.

No significant associations were found between piglet growth and sow nursing behaviour, in contrast to Valros *et al.* (2002) who found that nursing frequency was positively associated with piglet growth. Percent feed consumed by the sow was significantly correlated to piglet growth, which emphasis the importance of sow appetite. No associations were found between piglet growths and sow backfat loss or litter size. A possible explanation to this could be that the piglets were weaned late, at 7 weeks of age, and had unlimited access to sow feed from 2 weeks age. During the last weeks before weaning piglets probably compensated for poor milk production by eating sow feed, and maybe also by cross suckling. The long lactation probably also gave the sows a possibility to restore body fat loss before the ultrasound measurement at weaning.

Conclusions

- Sow nursing behaviour and sow activity are individual characters repeatable within lactation
- Litter size and sow backfat loss are related to nursing behaviour
- Sow appetite in early lactation is important for piglet growth until weaning
- Nursing behaviour and sow backfat loss are not significantly correlated to piglet growth when piglets are weaned at 7 weeks

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References

Damm, B.I. et al. 2003. *The gradual weaning process in outdoor sows and piglets in relation to nematode infections.* Appl. Anim. Beh. Sci. **82**: 101-120.

Framer, C. et al. 2001. *Lactation preformance, nursing and maternal behaviour of Upton-Meishan and Large white sows.* Can. J. Anim. Sci. **81**: 487-493.

Grandinson, K. et al. 2005. *Genetic analysis of body condition in the sow during lactation, and its relation to piglet survival and growth.* Anim. Sci. **80**: 33-40.

SAS Institute Inc. 2005. *SAS OnlineDoc®, Version 8.* SAS Institute Inc., Cary, NC, USA.

Thodberg, K., Jensen K.H. and Herskin M.S. 2002. *Nursing behaviour, postpartum activity and reactivity in sows: Effects of farrowing environment, previous experience and temperament.* Appl. Anim. Beh. Sci. **77**: 53-76.

Valros, A.E. et al. 2002. *Nursing behaviour of sows during 5 weeks lactation and effects on piglet growth.* Appl. Anim. Beh. Sci. **76**: 93-104.

Valros, A. et al. 2003. *Metabolic state of the sow, nursing behaviour and milk production.* Livest. Prod. Sci. **79**: 155-167.

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