Comparison of maternal abilities of Meishan and Large White breeds in a loose-housing system

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The maternal abilities and farrowing behaviour of 16 Large White (LW) and 16 Meishan (MS) gilts were compared in a loose housing farrowing environment. Females were inseminated with semen from the other breed in order to produce the same litter genetic type, i.e. LW x MS. Farrowing events took place over four successive batches. Sow behaviour was analysed over the first three hours after the onset of farrowing, by use of video recordings. LW gilts produced larger (15.2 *vs* 12.9 piglets born in total; P<0.05) and more heterogeneous litters (within-litter standard deviation of birth weight of 0.28 *vs* 0.19 kg; P<0.01), as well as heavier piglets (1.33 *vs* 1.14 kg; P<0.05). The number of stillbirths, farrowing duration and birth to weaning survival did not differ between breeds (0.6 stillborn piglet/litter in both breeds; 3.1 *vs* 3.5 h, P=0.56; 90 *vs* 84 %, P=0.15, in MS and LW sows, respectively). LW sows had a similar colostrum production, but produced more milk than MS. Relative sow weight loss during lactation was similar in both breeds. MS and LW differed in their behaviour at farrowing and during lactation. MS gilts spent more time in standing and performed more nesting behaviour at farrowing than LW gilts, which spent more time sitting (P < 0.05).
Key Words: pig, maternal abilities, farrowing behaviour, nursing behaviour
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1. Introduction

Current trends in European animal welfare regulations tend favour less constrained systems during gestation and lactation. An exacerbation of sow behaviour is expected in loose-housing as compared to crate-housing systems. Allowing an increased mobility of the sow at the time of parturition may enhance sow welfare , but can be detrimental for the survival and well-being of its piglets ((Cronin and Cropley, 1991, Weary *et al.*, 1996), through more crushing (Salaün *et al.*, 2004), lack of response to piglets distress calls, insufficient nursing frequency or aggressiveness towards newborn piglets, so that farmers are still often reluctant towards loose-housing systems. Several studies suggest that the large variation in piglet mortality in loose-housing can be due to individual differences in maternal ability (Johnson *et al.*, 2007), which may partly be of genetic origin. Indeed, both within- and between breed variation in maternal ability has been detected under standard housing systems (Grandinson, 2005), so that some genetic variation, likely larger than in conventional systems, can be expected under loose-housing.

A first trial aiming at investigating breed variation in maternal ability and piglet survival under loose-housing was developed at INRA through the comparison of 2 breeds known to have different maternal abilities under conventional housing : the Meishan, known for its excellent maternal ability (Bidanel *et al.*, 1989, Bidanel, 1993, Farmer and Robert, 2003) and the Large White (LW), the main dam breed used in France, with *a priori* lower maternal abilities. The aim of this paper was to present main results regarding breed differences for reproduction, piglet survival and growth as well as sow behaviour at birth and at the beginning of the nursing period.

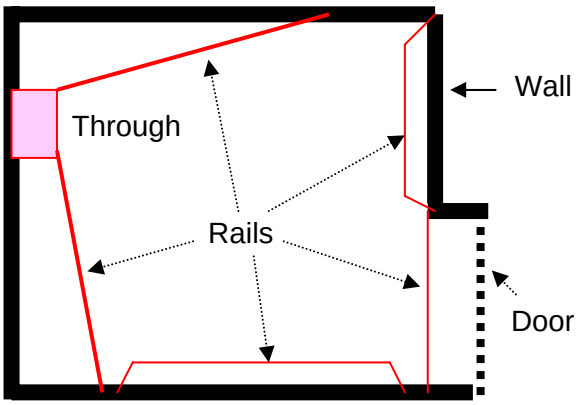
2. Materials and methods

2.1. Animals and data collection. Sixteen LW gilts were inseminated with semen from MS boars (n=5) and 16 MS gilts were inseminated with semen from LW boars (n=6) to give birth to F1 crossbred piglets in both groups. They were produced and raised in the INRA experimental herd of Le

Magneraud (Charentes-Maritimes, France). Gilts belonged to 4 different batches of 8 gilts (4 MS + 4 LW). Twenty eight parturitions were video recorded and analysed for behaviour at farrowing. Nine LW sows and 14 MS sows were also analysed for nursing behaviour during the first week of lactation.

Gilts were moved from their gestation pen to the loose-housing building approximately one week before farrowing. A farrowing unit included 8 individual pens. LW and MS gilts were placed in neighbouring pens in an alternative way (e.g. a LW gilt had MS neighbours). The pens were 2.8 m x 2.5 m, with a concrete floor covered with straw and bounded by 1.2 m high cement walls on the four sides. They included a piglet area delimited by rails positioned on two corners of the pen (see figure 1). Additional rails were placed at 0.25 m from the remaining walls and 0.2 from the ground. The room was lit both by natural daylight and artificial lighting maintained all around the clock.

Figure 1. Schematic representation of the farrowing pen



From day 111 of gestation, animals were daily visited to identify signs of impending parturition and reduce their apprehension towards human. Farrowings were not induced and no birth assistance treatment (i.e., ocytocin and vaginal palpations) was provided. There was no human intervention to control aggression towards newborns or avoid crushing. Although restricted, care was provided to the animals when essential to respect the general guidelines outlined in the European animal welfare regulations. Crossfostering was also prohibited in order to measure the sow capacity to raise its own litter but creep feed was available for the piglets on the 4th (last) week of lactation. Farrowing supervision without permanent disturbance of the progress of farrowing was facilitated by video watching from an adjacent room. Farrowing events were permanently supervised all along the farrowing week.

Each expelled piglet was immediately caught with tongs from outside the pen. The measurement protocol was similar to that described in Canario (2006). Piglets were counted and classified as alive or stillborn at birth. To avoid misclassification, all hypothesized stillborn piglets were confirmed as such by necropsy. Prenatal deaths were distinguished from other deaths. Piglets were weighed at birth, 1, 2, 4, 7, 21 days and at weaning as described in Canario (2006). Colostrum and milk production were estimated from litter weight gains during the first 24h and the 21 first days of lactation using prediction equations determined by Noblet and Etienne (1989) and Devillers *et al.*, (2004), respectively. Sow body condition was evaluated through body weight and average backfat thickness measurements before farrowing and at weaning. All piglet mortality events were carefully registered during lactation.

Sow behaviour was recorded from their entrance in the farrowing unit to d6 after farrowing using 24 time lapse video (VHS Panasonic video recorder associated with DPX9 *multiplexer Advanced Technology Video*). Video tapes were analysed by continuous observations. A first analysis was performed to record the birth time of each piglet and compute farrowing duration and rhythm. Additional analyses were limited to a 3h period beginning with the birth of the first piglet at farrowing and to a 6h period beginning at 6pm on day 6 after the end of farrowing).. The behavioural aspects investigated included sow postural activity, udder exposition and nesting activity. A precise definition of the behavioural criteria used is given in table 1. Behavioural analyses were performed on all available video tapes, but recording problems at farrowing led us to remove farrowing records from 4

LW gilts. Similarly, only 14 MS and 9 LW sows could be considered in d6 due to recording problems. Recorded items referred to the general activity of the sow and to the nursing activity. A nursing period started when at least 3 piglets were active at the udder. A nursing was considered as nutritive when milk ejection occurred, as seen from the piglets freezing in their activity, between 2 periods of massage. A sow started a nursing period when she called the piglets while exposing the udder in a lying laterally position. She stopped the nursing when turning to hide the udder despite 3 piglets were still suckling.

2.2. Statistical analyses. Performance traits analysed included gestation length, sow body weight and backfat thickness before farrowing, weight and backfat loss during farrowing and lactation, farrowing duration, numbers of piglets born in total, born alive, stillborn, dead during the first week of lactation, dead on weeks 2-4 and weaned, litter and individual piglet weight at birth, within-litter standard deviation in piglet weight, piglet average daily gain on d 1-2, 2-4, 4-7, 7-21 and 21-28, colostrum and milk production, as well as litter size at weaning.

Behaviour traits at farrowing included the amount and proportion of time spent lying laterally, ventrally, sitting, standing and nesting, the number of postural changes and of nose contacts with piglets. Behavioural traits at d6 also included the proportion of time spent in different positions (lying laterally with and without udder exposed, lying ventrally, sitting and standing, the number and proportion of nutritive and non nutritive nursings, the mean duration of nutritive nursings and the percentage of nursings initiated and ended by the sow.

Performance traits were analysed with a linear model including the fixed effects of sow breed and batch using the GLM procedure of the SAS software (SAS Institute, 2001). Piglet traits (birth weight, average daily gain) were analysed with a model including the sow breed and batch, plus an additional random effect of the litter, using the MIXED procedure of SAS (SAS Institute, 2001).

Traits related to the time spent in different positions were analyzed assuming a Poisson distribution, using the GEE option from the SAS GENMOD procedure, with a correction for overdispersion and the ln (time of observation) as offset option (SAS Institute, 2001). The model included the fixed effects of farrowing batch and breed.

Contacts with the piglets were analysed in 30min periods. The model included the fixed effects of batch, breed, period and the breed x period interaction. Data at day 6 were analysed over the whole 6 hours period analysed: the model included the fixed effects of batch and group. The GLM procedure of the SAS software was used (SAS Institute, 2001). Breed estimates were then back transformed to the original scale.

3. Results

3.1. Characteristics at farrowing. Breed estimates of farrowing performances are shown in Table 1. LW sows gave birth to 15.3 born piglets, i.e. 2.3 piglets more than MS sows. The number of stillborn piglets was remarkably low and similar in both groups. Survival rate until weaning was high in both groups (90% and 84% in MS and LW sows, respectively). LW sows were bigger, leaner at farrowing, gave birth to piglets that were heavier and more heterogeneous, and then had a higher growth rate during lactation, sign of a higher milk production of LW sows. Farrowing duration and colostrum production were the same in the two groups.

MS sows spent more time nesting (handling straw) and having nose contacts with the piglets whereas LW sows spent more time sitting. The 2 breeds did not differ in time spent lying and in the number of postural changes over the three 1st hours after onset of farrowing.

3.2. Characteristics during lactation. Mortality during lactation was quite low in both groups: only 16 piglets from MS sows and 21 piglets from LW sows died during the first week of lactation (among 197 and 217 piglets born alive, respectively). The number of deaths was identical in both groups during the first week, even after adjustment for NBA. The probability of having dead piglets was similar on d1, d2, d3+4 and d5+6+7. Birth to weaning survival did not differ between breeds.

Litters from LW sows grew quicker than those raised by MS sows. The milk production was higher in LW than in MS sows (38.2 *vs* 48.6 kg piglets, p=0.001) but the 2 groups had a similar body weight at weaning. Litters from MS sows were still more homogeneous at 3 wks than that raised by LW sows (0.9 *vs* 1.5 SD). MS sows had a lower weight loss during this period (35.2 *vs* 53.4 kg, p= 0.001) but the 2 breeds had a similar relative weight loss. Backfat loss was similar (7.3 vs 7.1 mm in MS and LW respectively, p=0.89), but higher in LW when expressed as a ratio (17.5% *vs* 28.3 %, p=0.01).

Table 1. Comparison of farrowing characteristics of Meishan (MS) and Large White (LW) sows and of their crossbred piglets in a loose-housing system.

	No. MS	No. LW	MS LSmean	LW LSmean	Difference (LW-MS)	Prob: LW-MS=0
Sow traits						
Gestation length (days) *	16	16	114.5	114.6	0.1	0.74
Backfat thickness (mm)	16	16	45.6	25.1	-18.5	0.0001
Body weight (kg)	16	16	169.9	251.8	81.9	<0.0001
Farrowing duration (h)	16	16	3.1	3.5	0.4	0.56
Litter traits						
Number born in total	16	16	12.9	15.2	2.3	0.06
Number born alive	16	16	12.3	14.6	2.3	0.04
Number stillborn	16	16	0.56	0.56	0.00	1.00
Individual piglet weight	197	217	1.13	1.33	0.20	0.02
Litter weight (kg)	14	15	14.42	20.04	5.62	0.005
Within-litter SD in weight	14	15	0.19	0.28	0.10	0.005

* with adjustement for litter size

Table 2. Comparison of behaviour between MS (n=16) and LW (n=12) sows over the 3 first hours of

Trait	MS mean	LW mean	Difference (LW-MS)	P-value
Lying laterally (min/proportion)	127.4/0.708	128.3/0.713	0.005	0.96
Lying ventrally (min/proportion)	12.8/0.071	23.9/0.133	0.062	0.17
Sitting (min/proportion)	2.5/0.014	4.9/0.027	0.013	0.12
Standing (min/proportion)	34.2/0.190	18.7/0.104	0.086	0.11
Number of postural changes	69	60	-9	0.61
Nesting (min/proportion)	17.4/0.095	6.2/0.034	-0.061	0.02
Nose contacts with piglets (nb/30min)	5.2	3.0	-3.2	0.001

Table 3. Comparison of production traits during lactation of MS and LW sows.

Trait	MS mean	LW mean	Difference (LW-MS)	P-value
Mortality				
Nb dead the 1st week	0.00	0.34	0.34	0.31
Nb at weaning	11.0	12.2	1.2	0.22
Survival rate to weaning (%)	90.3	84.5	-5.8	0.15
Litter size at weaning (nb)	11.0	12.2	1.2	0.22
Litter growth				
Litter growth 0-1 d (kg)	0.79	0.98	0.19	0.79
Litter growth 1-2 d (kg)	0.58	1.74	1.16	<0.001
Litter growth 2-4 d (kg)	2,60	4.30	1.70	<0.001
Litter growth 4-7 d (kg)	5.37	7.31	1.94	0.01
Litter growth 7-21 d (kg)	29.7	35.2	5.5	0.01
Litter growth 21-28 d (kg)	15.2	14.2	-1.0	0.61

LW sows spent more time sitting and lying on the belly than MS sows on the 6th day after farrowing, (Table 4). They also started and ended nutritive nursing more frequently than MS sows. No difference

was observed in the duration and frequency of nursing events, but MS sows showed a lower proportion of non nutritive nursings than LW.

4. Discussion

Both breeds performed well in this loose-housing system. This is particularly true for LW gilts, whose average performance is superior to French average performance for LW (15.0 number born in total over all parities). Though obtained on a small sample, it confirms the high efficiency of selection for increased litter size carried out in French Large White over the last 15 years (Tribout *et al.*, 2003). The performance of Meishan is similar to that reported by Bidanel (1993) over 5 parities, but slightly lower than the value obtained by Bidanel *et al.* (1989) over 3 parities – 13.0 and 14.9 total number born, respectively. Stillbirth and mortality during lactation were very low in both breeds, which tends to show that well-designed loose-housing systems can perform at least as well as standard housing systems. This contrasts with poor the results obtained in a previous French study (Salaün *et al.*, 2004) where dramatic mortality rates were reported. Differences in pen size and installation might at least partly explain these differences. The higher growth of F1 piglets raised by LW sows as compared to MS are in line with those reported by (Bidanel *et al.*, 1990) and (Lee and Haley, 1995); these latter authors also showed a lower within-litter standard deviation in piglet birth weight.

Table 4. Comparison of nursing during the 6th day of lactation for MS and LW sows.

Trait	MS mean	LW mean	Difference (LW-MS)	P-value
% Time spent				
Lying laterally with udder exposed	77.8	77.1	-0.7	ns
Lying ventrally	5.7	13.4	7.7	0.05
Standing	8.2	3.4	-4.8	0.05
Nutritive nursing				
Number	8.3	7.7	0.6	ns
%	70	58	-12	ns
Mean duration (min)	10.2	11.2	1.0	ns
Nursing initiation (%)	53.4	66.9	13.5	0.06
Nursing ending (%)	25.8	32.8	7.0	ns
Non nutritive nursings				
Number	3.6	6.1	+2.5	0.05
%	2.6	2.3	-0.3	ns

Behavioural analyses showed that LW sows at farrowing seem to be attentive towards their newborn piglets from a distance, as previously shown in crate housing (Canario, 2006). MS gilts were more involved in straw handling (nest arrangement), in relationship with a greater explorative activity, and they were more engaged in contacts with their piglet, which might be interpreted as a higher curiosity. Apart from those differences, the two breeds were rather similar in their farrowing activity. In early lactation, LW tended to limit the access to the udder and had a better control of milk provision (they initiated nursings more often than their piglets). Conversely, MS might be more efficient nurses since they had less non nutritive nursings. Yet, it should be emphasized that MS and LW had almost certainly synchronised their nursing activity at this time of lactation, which could explain why they exhibited similar duration and frequency of nursings. Despite this fundamental similarity, piglets from LW sows grew faster, strongly suggesting a better milk production and/or quality than MS sows.

5. Conclusion and perspectives

Maternal abilities are a key issue in pig production. The results of this study showed that contrary to expectations, LW may have better maternal abilities than MS sows, at least in loose-housing system. Indeed, the progeny of LW sows was more numerous and grew faster than MS progeny due to a higher investment of the dam (higher weight loss). Moreover, they were calm at farrowing and had closer relationships with their progeny (attention and attempt to control the mother-young conflict).

Yet, good maternal abilities refer to an optimal investment in the current litter without jeopardizing that of the next. It may be questioned whether the high investment of LW sows towards their progeny may unfavourably affect their second litter and, more generally, their future career.

Yet, due to the low number of animals, the rather favourable environmental conditions and the limited period of time considered in behavioural analyses, these results should be considered as preliminary and have to be confirmed on a larger scale, over a longer period of time and in a wider range of loose-housing conditions.

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