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contact : nathalie.quiniou@ifip.asso.fr

IMPACT OF SOME SOW'S CHARACTERISTICS ON BIRTH WEIGHT VARIABILITY

N. Quiniou[1], L. Brossard[2], H. Quesnel[2]

[1] IFIP-Institut du porc, BP 35104, 35651 LE RHEU cedex, FRANCE

[2] INRA, UMR1079 Systèmes d'Elevage Nutrition Animale et Humaine, 35590 SAINT-GILLES, FRANCE

INTRODUCTION

As the result of genetic selection for improved prolificacy of sows, litter size increased from 11.9 total born piglets in 1996 to 13.7 ten years later. Such an evolution was associated with some modifications of litters' characteristics. Within-litter heterogeneity of birth weight increased and resulted in a higher number of small piglets. Similarly, in a given herd, the biggest the litters are, the highest is the proportion of small piglets. Now, their survival rate is lower than their heavier littermates (Quiniou et al., 2002), what slows down the technical and economical progress expected from hyper prolificacy (+1.1 weaned piglet). In addition, growth performances of small piglets that survive until weaning are usually poorer. Then, birth weight heterogeneity generates heterogeneity in weaning weight as well as slaughter weight or age at slaughter (Le Cozler et al., 2004).

The aim of the present study was to determine if some characteristics of the sow might explain some part of the within-litter heterogeneity. For this purpose, data recorded systematically in an experimental station were analysed.

MATERIAL AND METHODS

Data set

Data collected in the experimental station of IFIP-Institut du Porc (Romillé, 35- France) were used to quantify within-litter variability of birth weight. Calculations were performed from 1380 litters born between December 2000 and August 2005 from Large White × Landrace sows born between January 2000 and August 2004. At farrowing, number of total born piglets, number of piglets born alive and number of stillborn piglets were recorded. Within the 24 h post-farrowing, born alive and stillborn piglets were individually weighed. During gestation, feed allowance was adapted individually for all sows to body condition at mating. Neither birth weight nor its heterogeneity was affected by treatments studied during trials that were carried out over the sows taken into account in the data set.

Calculations and statistical analyses

For each litter, mean birth weight (mBW) and its coefficient of variation (cvBW) were calculated. In addition, piglets were categorised with regard to the difference between their birth weight and the mBW of their litter. Four classes were considered corresponding to piglets weighing less than 75% of mBW, between 75 and 100% of mBW, between 100 and 125% of mBW or 125% and more of mBW. Different factors were considered to describe the sows' characteristics: parity, birth year, prolificacy, season at conception, body reserves at conception, and at the end of the gestation (assessed from the backfat thickness ultrasonically measured at the P2 site).

Correlations between criteria and studied factors were tested using proc CORR (SAS, 1998). Their effects were also tested through an analysis of variance (proc GLM, SAS, 1998). Litter size was categorised in five classes: less than 10 total born piglets, 10-11, 12-13, 14-15, 16 and more. Parity was categorised in five classes: 1st, 2nd, 3 and 4th, 5 and 6th, 7th or more. Effect of birth year was tested within parity and effect of categorised litter size was tested within parity taking into account the significant correlation between categorized litter size and parity (r= 0.13, $P < 0.001$). Season at conception was considered through the first, second, third or fourth trimester of the year. Sow repeatability (r) was defined as the correlation between successive litters from the same sow. It was estimated from sow (Vs) and residual (Vr) components of the variance according to r = Vs/ (Vs+Vr). The values of Vs and Vr were obtained by using proc Mixed with the fixed effect of parity (categorised), batch and age, and sow as the permanent environmental effect.

RESULTS AND DISCUSSION

From our data set, repeatability of litter size and mBW were 0.18 and 0.39, respectively, which is close to values reported by Nguyen et al. (2006, 0.14 and 0.33, respectively). Repeatability of cvBW was small (r=0.12), indicating that most of the phenotypic variance is explained by other factors than sows' variance.

Litter size

From 1380 litters, litter size averaged 14.1 total born piglets. It was significantly influenced by parity($P < 0.001$, Table 1) as well as born alive and still born piglets. As detailed in Table 2, primiparous sows farrowed 13.9 piglets. A lower litter size was obtained at 2nd farrowing Insemination of gilts at their second or third oestrus contribute to their higher litter size in first parity (Dourmad et al., 1999), whereas intense body reserve mobilisation during first lactation contribute to a reduce litter size in second parity (Quiniou, unpublished results). In older sows, subsequent litter size was less sensitive to body reserve mobilization during previous lactation and in the present herd litter size increased up to 16.1 piglets at the 6th parity.

Mean birth weight and its heterogeneity

Mean BW and cvBW averaged 1.53 kg and 20.8%, respectively, for 14.1 total born piglets (Table 1). Mean BW was mainly influenced by parity ($P < 0.001$), litter size ($P < 0.001$), and birth year of the sow ($P < 0.05$) and, but not by season. Birth year and parity effects might partly influence mBW through their effect on litter size but litter size *per se*. influenced significantly mBW (Table 2, Figure 1a).

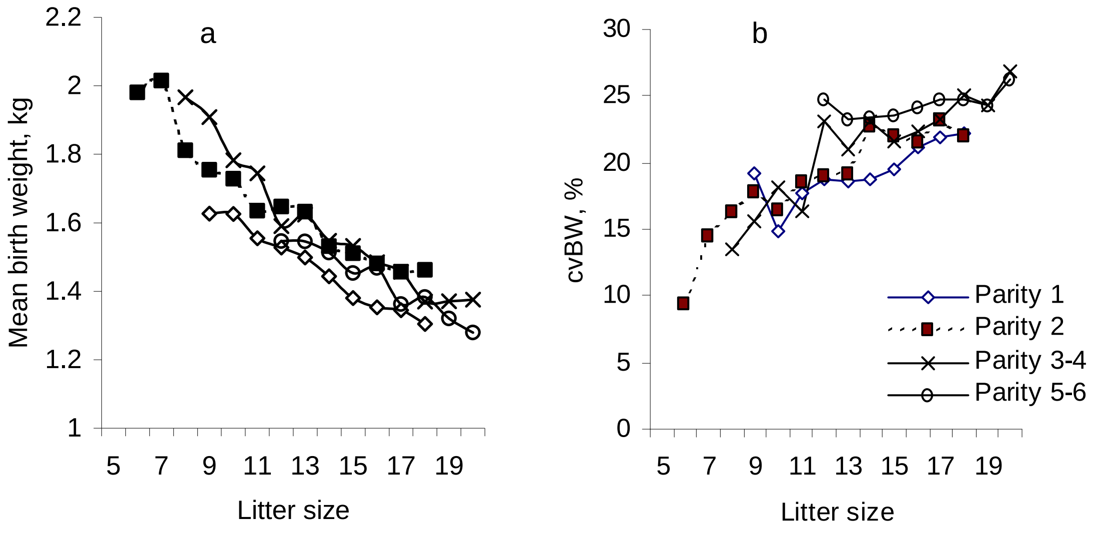

Figure 1: Evolution of mean birth weight (a) and its coefficient of variation within litter(b) with litter size within parity (at least 10 data per point).

Table 1: Characteristics of litters born between 2000 and 2004 (statistics).

			Statistics[1]					
	Mean	Standard deviation	R^2	Parity	Birth year	Litter size	Season	Year × Season
Number of observations	1380							
Mean parity	2.9	1.8	0.11	-	***	-	ns	ns
Gestation length, d	114.5	1.0	0.10	ns	***	*	ns	ns
Litter size								
Total born	14.1	3.6	0.13	***	ns	-	ns	ns
Born alive	13.2	3.3	0.10	***	ns	-	ns	ns
Still born	0.9	1.3	0.08	***	ns	-	ns	ns
Litter weight, kg	20.9	4.5	0.66	***	ns	***	ns	ns
Individual birth weight (BW), kg								
Mean (µ)	1.53	0.26	0.50	***	*	***	ns	ns
Standard deviation	0.31	0.10	0.14	***	ns	***	ns	ns
Coefficient of variation, %	20.8	7.1	0.22	**	ns	***	ns	ns
Within-litter BW partition, %								
Less than 0.75 × µ	12	9	0.19	**	ns	***	ns	ns
Between 0.75 × µ and µ	34	13	0.09	*	ns	***	ns	ns
Between µ and 1.25 × µ	45	14	0.11	ns	ns	***	ns	ns
1.25 × µ and more	10	9	0.18	**	ns	***	ns	ns

1. Analysis of variance with year of sow's birth (Y), parity (categorised in five classes) within birth year, litter size within parity, season at conception (S), interaction Y×S as main effects, R^2 of the statistical model.
** P < 0.05, ** P < 0.01, *** P < 0.001, ns : non significant.*

Table 2: Characteristics of litters born between 2000 and 2004: mean values per litter size and parity[1].

	Litter size (total born piglets)					Parity				
	9 and less	10-11	12-13	14-15	16 and more	1	2	3-4	5-6	7 and more
Nombre	161	134	245	334	506	391	312	410	207	58
Parity	2.6	2.3	2.5	2.6	3.5	1.0	2.0	3.4	5.4	7.4
Litter size										
Total born	7.2	10.6	12.6	14.5	17.6	13.9	12.2	14.6	15.7	15.4
Born alive	7.0	10.2	11.9	13.8	16.2	13.2	11.7	13.7	14.4	13.5
Still born	0.3	0.4	0.6	0.7	1.5	0.8	0.5	0.9	1.3	1.9
Individual birth weight, kg	1.89[a]	1.67[b]	1.57[c]	1.47[d]	1.38[e]	1.45[a]	1.64[b]	1.56[c]	1.45[a]	1.44[a]
Coefficient of variation, %	14.9[a]	17.4[b]	20.2[c]	21.3[c]	23.7[d]	19.4[a]	19.2[a]	21.6[b]	23.9[c]	22.9[bc]
Within-litter BW partition, %										
Less than 0.75 × µ	6[a]	8[b]	11[b]	12[c]	16[d]	11[a]	10[a]	13[c]	15[c]	15[cb]
Between 0.75 × µ and µ	39[a]	36[b]	34[bc]	33[c]	31[d]	36[a]	34[ab]	32[bc]	32[bc]	31[c]
Between µ and 1.25 × µ	51[a]	50[a]	46[b]	44[b]	41[c]	46	47	44	39	43
1.25 × µ and more	4[a]	5[a]	9[b]	10[b]	13[c]	8[a]	8[a]	10[b]	14[c]	12[b]

1. See statistical effects in Table 1. Within each group of results (either per litter size or per parity), means with different letters within a line are significantly different (*P* < 0.05).

Sows' explained less than one fourth of variability of cvBW characteristics taken into account, the major ones being the size of the litter farrowed ($P < 0.001$) and the parity ($P < 0.01$). The cvBW increased from 15 to 24% when litter size increased from 9 and less to 16 and more piglets (Tableau 2, Figure 1b). A significantly increased heterogeneity was observed in oldest sows (22-24%) when compared to first and second parities (19% on average). This evolution with litter size and parity resulted in different proportions of small piglets within the litter.

As mBW and cvBW were both influenced by litter size and parity, considering the individual BW was not sufficient to define a small piglet or a large piglet. Then, small piglets were considered as piglets whose BW was 25% lower than the mBW of their litter and large piglets those weighing more than 25% above mBW. In such conditions, calculations indicated that proportion of small piglets increased from 6 to 16% ($P < 0.001$) when litter size increased from 9 and less to 16 and more piglets (Figure 3). It averaged 11% in litters from youngest sows and reached 15% in oldest ones (Tableau 2). Corresponding proportions of large piglets were 4 and 13% in smallest and largest litters, respectively, and 8 and 13% from youngest and oldest sows, respectively. Similarly to the consequence of genetic selection over time (Tribout et al., 2003), increased cvBW with litter size in a given herd over a short period was associated with increased proportions of both small and large piglets.

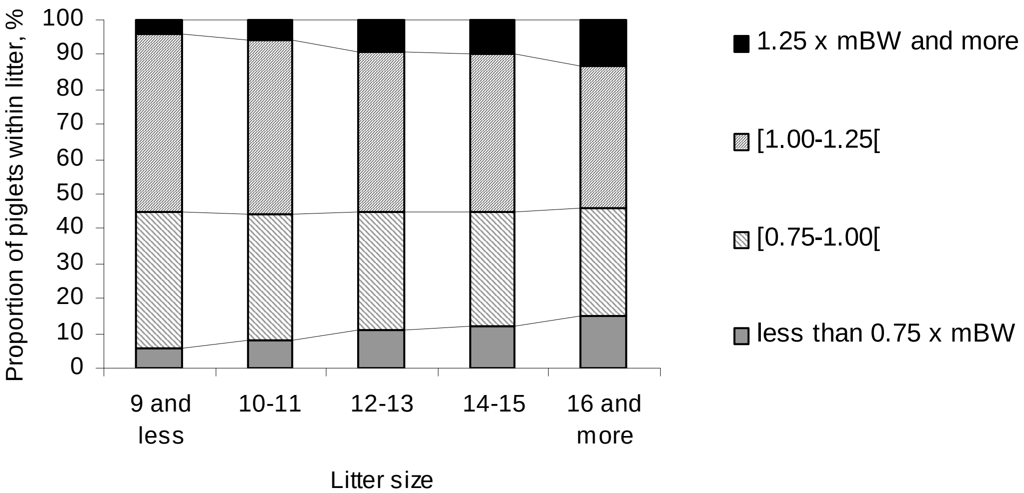

Figure 3: Effect of litter size on piglets' within-litter partition with regard to their birth weight relatively to the mean birth weight in the litter (mBW).

Significant correlations were found between some characteristics of sow's body condition. Heterogeneity increased with body weight at the beginning of gestation and after farrowing as indicated by significant (even not so high) Pearson's coefficients (Table 3). Parity contributed partly to this correlation as body weight increases with age (Figure 4). However, when considering separately the five classes of parity, correlation with initial body weight remained significant for 2nd, 3rd and 4th litters. In opposite, less significant correlations were observed with final body weight, as it remained significant only for older sows (5-6th litters). This lower influence of final body weight could be explained by the feeding plan applied during gestation that consisted in adaptation of feed allowance to the required repletion of body reserve after weaning. Subsequently, body weight range was smaller at the end than at the beginning of gestation, and relationship with cvBW more difficult to observe.

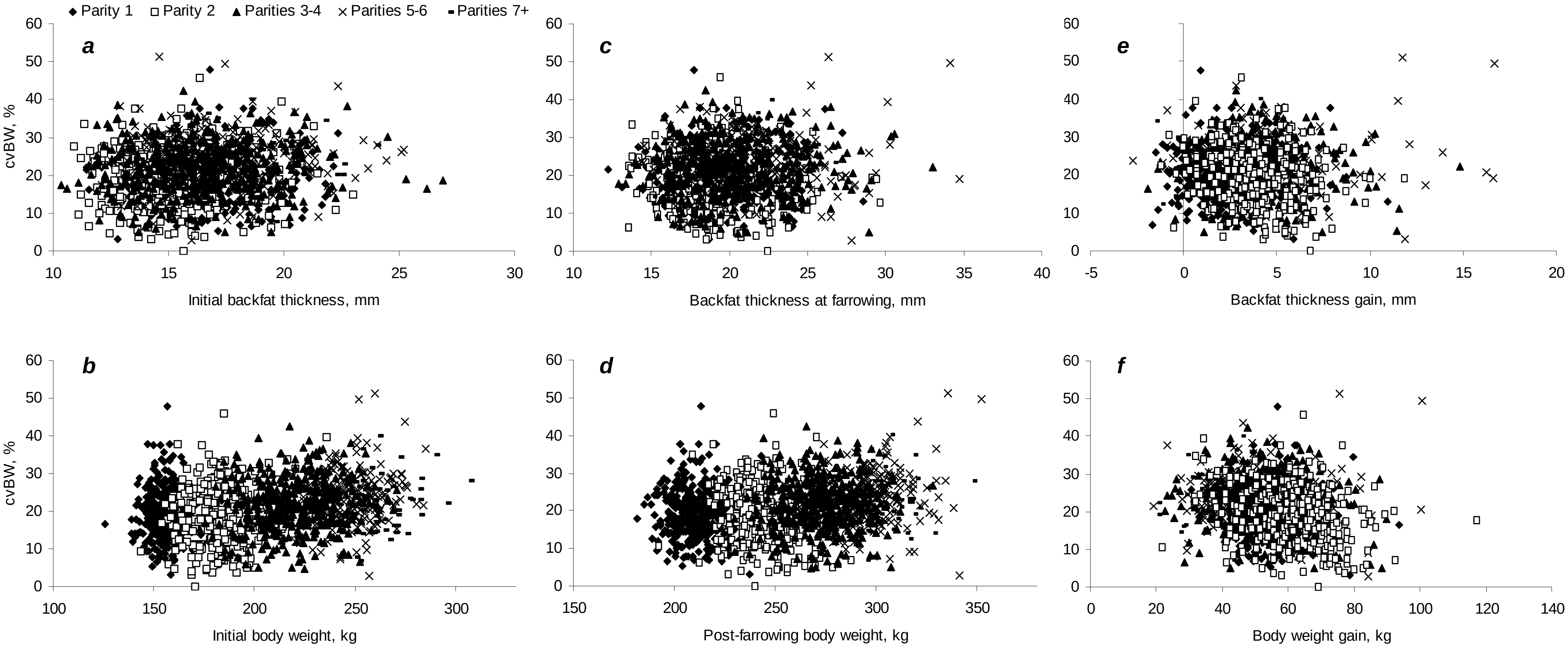

Figure 4: Individual relationship between coefficient of variation of birth weight (cvBW) and backfat thickness (a) and body weight (b) at the beginning of gestation, backfat thickness (c) and body weight (d) at farrowing and backfat thickness (e) and body weight (f) gains during gestation.

Table 3: Pearson's correlation coefficient between coefficient of variation of birth weight (cvBW) and body condition of the sow during gestation.

Sow's parity[1]	All sows	1st litter	2nd litter	3-4th litters	5-6th litters	7th litter and more
Body weight						
Initial	0.24 ***	0.03	0.11 *	0.11 *	0.13 $^{P=0.07}$	0.01
Final	0.21 ***	0.00	-0.10 $^{P=0.07}$	0.05	0.15 *	-0.01
Variation	-0.16 ***	-0.04	-0.24 ***	-0.09 $^{P=0.06}$	0.04	-0.03
Backfat thickness						
Initial	0.10 ***	0.04	0.08	0.05	0.03	0.09
Final	0.06 ***	0.01	-0.08	0.03	0.03	0.10
Variation	-0.02 ns	-0.05	-0.20 ***	-0.01	0.01	0.03

1. Number of observations: 1316 for body weight, 1371 for backfat thickness.

The cvBW and body weight gain were negatively correlated and this correlation was mainly due to 2nd parity sows (Table 3). Even if the Pearson's correlation coefficient was small, it indicated that body reserve repletion during the 2nd gestation would not only contribute to improve body condition of young sows after their 1st weaning but also reduce BW heterogeneity. In other words, insufficient body reserve repletion would compromise litters' homogeneity from young sows. Such a correlation may explain why cvBW in 2nd parity was not lower than in 1st parity, despite a lower litter size.

Significant correlation was found between cvBW and backfat thickness at the beginning and the end of gestation ($P < 0.001$) (Figure 4). However, the Pearson's correlation coefficients were very small and no longer significant when parities were considered separately (Table 3). On the opposite, correlation between cvBW and backfat thickness gain during gestation was not significant from all parities, whereas a negative and significant correlation was found in 2nd parity sows (r = 0.20, $P > 0.001$). In other terms, similarly to correlation observed above with body weight gain, less heterogeneous litters would be obtained when backfat thickness gain increases.

Body weight and backfat thickness variations during gestation were significantly correlated: Pearson's correlation coefficient averaged 0.49 ($P < 0.001$) from all parities and 0.59 ($P < 0.001$) for 2nd parities. These variations increased when initial body weight (r = - 0.36, $P < 0.001$) or initial backfat thickness (r = -0.19, $P < 0.001$) decreased. This is consistent with adaptation of feed allowance during gestation to body reserve mobilisation during lactation. Correlation between cvBW and sow's body condition is biased by the impact of nutritional status during lactation not only on body weight and backfat thickness at weaning but also on further prolificacy especially at the 2nd parity. Indeed, primiparous sows seem to be more sensitive to low feed intake during lactation, i.e. intensive body reserve mobilisation, with regard to consequences on both embryo survival and ovulation rate (Zak et al., 1997). Besides a positive correlation was found between backfat thickness at the beginning of the 2nd gestation and subsequent litter size from our data set (r = 0.15, $P < 0.01$). Such a correlation was not observed in younger and older sows.

CONCLUSION

Coefficient of variation of birth weight increased with litter size and parity and was above 20% in largest litters. When only 2nd parity was considered, a small but significant correlation was found between cvBW and body weight and backfat thickness gains during gestation. Impact of variation of sow' body condition during the 2nd gestation was partly confounded with the impact of body condition of weaned primiparous sows on litter size. However, findings indicated that repletion of body reserves during the 2nd gestation would contribute to reduce the within-litter heterogeneity of birth weight. Taking into account the effects of birth year of the sow, parity, season at conception and litter size explained less than one fourth of within-litter birth weight heterogeneity. In addition, this criterion is not repeatable from parity to the following. Then, major part of heterogeneity is due to other factors. Weighing pigs within the first 24 hours as performed in this study instead of weighing before the 1st suckling of colostrum may increase the apparent variability of birth weight. Further studies should focus on factors influencing foetus development over the early and/or the late gestation.

REFERENCES

Le Cozler Y., Pichodo X., Roy H., Guyomarc'h C., Pellois H., Quiniou N., Louveau I., Lebret B., Lefaucheur L., Gondret F. 2004. Influence du poids individuel et de la taille de portée à la naissance sur la survie du porcelet, ses performances de croissance et d'abattage et la qualité de la viande. J. Rech. Porcine 36: 443-450.

Nguyen N.H., McPhee C.P., Wade C.M. 2006. Genetic variation and responses in reproductive performance of sows in lines selected for growth rate under restricted feeding. Anim. Sci. 82: 7-12.

Quiniou N., Dagorn J., Gaudré D. 2002. Variation of piglets' birth weight and consequences on subsequent performance. Livest. Prod. Sci. 78: 63-70.

SAS 1998. SAS Inst.Inc.cary, NC, version 8.02.

Tribout T., Caritez J.C., Gogué J., Gruand J., Billon Y., Bouffaud M., Lagant H., Le Dividich J., Thomas F., Quesnel H., Guéblez R., Bidanel J.P. 2003. Estimation, par utilisation de semence congelée, du progrès génétique réalisé en France entre 1977 et 1998 dans la race porcine Large White : résultats pour quelques caractères de reproduction femelle. Journées Rech. Porcine, 35: 285-292.

Zak L.J., Cosgrove J.R., Aherne F.X., Foxcroft G.R., 1997. Pattern of feed intake and associated metabolic and endocrine changes differentially affect postweaning fertility in primiparous lactating sows. J.Anim.Sci. 75: 208-216.

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ABSTRACT

Data collected from 1380 litters born between 2000 and 2004 from Large White × Landrace sows were used to quantify within-litter variability of birth weight in an experimental herd. Born alive and stillborn piglets were individually weighed within the 24 h post-farrowing. For each litter, average birth weight (mBW) and its coefficient of variation (cvBW) were calculated. Litter size and parity were correlated (Pearson's correlation, r = 0.13, $P < 0.001$). Subsequently litter size effect was tested within parity in a variance analysis. Other main effects were parity, , year of sow birth, and season of conception. Within-litter cvBW averaged 21% and mBW 1.53 kg. The cvBW was not significantly repeatable from a parity to the following. It was significantly influenced by litter size and parity. Lowest cvBW were obtained in first and second parities (19%) and thereafter the cvBW increased by 1.42 (±0.18) point per additional litter up to the 6th. Increase in litter size within parity was associated with increased variability of BW that averaged +0.80 (±0.05) point per additional piglet. The cvBW was negatively correlated with sows' body weight gain during gestation (r= -0.16), but not with backfat thickness gain, except in second parity sows (r= -0.20). In fact, this correlation reflected a simultaneous reduction of 2nd litter size in the thinnest weaned sows.