INFLUENCE OF BOARS ORIGIN AND USEFULNESS ON THE REPRODUCTIVE PERFORMANCE OF SOWS

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Abstract. The results presented in this manuscript originate from a breeding farm keeping a foundation herd of 240 sows of the Polish Large White (PLW) breed. Out of 65 PLW boars bred at the farm within the last three years, 8–10 boars were selected at random that were born in litters 1–2 and 3–5 (groups I and II). Another 8 boars were born in the successive 6–8 litters of long-living mothers (group III). Out of all 26 boars selected (40% of 65 boars were kept at the farm), 14 were reared in large mother's litters – group ***A*** (mean number of piglets at the age of 21 days – over 10.1), and 12 boars originated from less fertile mothers – group ***a*** (10 and less piglets at the age of 21 days). This way of dividing boars into experimental groups was used to show the difference among the ones reared by sows of high and low fertility.

The boars born in litters of long-living sows (6–8 – group III) and of highly fertile sows (group A) were characterized by the highest adjusted daily gains at the age of 180 days. They additionally had a tendency for deposition of lesser backfat determined with the performance test ($P<0.01$). Sows that were mated by the boars originating after mothers from group ***A*** were characterized by a higher number of piglets in a litter and a higher weight of litter at the age of 21 days ($P< 0.05$ and 0.01) than the sows mated with the boars originating after mothers from group ***a***. A greater litter size by 0.8 – 1.0 piglet was reported in subgroups IA, IIA and IIIA. The coefficient of correlation between litter size of boars' mothers and fertility of sows mated by those boars was positive ($r = 0.182$), whereas between mothers' fertility and litter size at the age of 21 days it was higher ($r = 0.233$ – tendency for better viability of piglets). The adjusted daily gains of the boars were highly significantly correlated with the number of piglets at the age of 21 days in the litters of sows mated by those boars ($r = 0.184$ and $r = 0.259$ respectively) and with litter body weight ($r = 0.309$), which indicates that body weight gains of the boars and high fertility of their mothers are good prognostic indicators of their future reproductive performance. Presumably, those traits are linked with greater resistance to environmental conditions.

Keywords: pigs, boars origin, results of boars performance test, reproductive traits of sows, correlations

Introduction. A number of unfavorable phenomena may be observed in the rearing and breeding of livestock, including: high death rate of piglets, frequent diseases of the respiratory system or severe problems in reproduction. Apart from economic losses linked with treatment procedures, increasingly significant becomes the problem of the safety of food products originating from intensively-treated animals (Flachowsky and Gabel 2003). A question arises whether the high frequency of diseases is due to diminished genetic resistance of animals. It may be assumed that the length of productive life and fertility of sows are indicative of high resistance.

According to Głód and Kaczmarczyk (1982), long-living sows are especially valuable for they may transfer this trait to their progeny. A study by Jarczyk et al. (1990) demonstrated that under conditions of commercial breeding, out of 2000 sows examined ca. 1% delivered 15 and more litters, and that diminished fertility and extension of the opening period occurred already since the 10th litter.

However, transferring higher environmental resistance to progeny by their parents is complicated by negative maternal effects and especially effects of the environment of highly fertile and long-living mothers (Jarczyk and V.D. Steen 1988; Jarczyk et al. 1992; Jarczyk and Konrad 2000). There are few works analyzing the effect of longevity of sows – boars' mothers. This trait is linked with animals' resistance to unfavourable effects of a specific environment. The combined effect of those two factors has hardly ever been investigated. The selection in terms of longevity and high fertility is rendered difficult because of, among other things, the above-mentioned maternal effect. In poorer environmental conditions (feeding, concentration of animals), this effect influences a lower growth rate of young commercial boars (Jarczyk et al. 1992; Jarczyk 1998), preferring animals reared in smaller litters. The second maternal effect causes that daughters originating from litter 6–7, after long-living mothers, deliver fewer litters ($P<0.05$) than their halfsisters born in the first litters, which was demonstrated in a study by Jarczyk and Konrad (2000). Other investigations (Klocek et al. 1999) showed that sows born in the 5th and successive litters delivered less piglets in a litter (by 0.41 piglet) than the sows born in the 1st litter.

A research by Falkowski and Kozera (1999) indicates that at insemination stations with appropriate rearing conditions the productive life of boars reached 808 days (2.2 years). In turn, Milewska et al. (2003) reported that at insemination stations the boars with the longest productive life – 743 days – were those of the Large White breed. Excluding the effect of various factors on changes in this trait, the results presented suggest that the length of the productive life of boars is subject to stagnation and even to shortening. A question thus arises, are there any selective parameters of traits affecting - through boars - the increase in the basic reproductive results of sows mated by them and to what extent they affect those results. According Klimiene and Klimas (2013), it is important to consider different productivity indicators and genetic parameters as correlation coefficient too.

The objective of this study was to determine whether

and to what extent boars originating from long-living mothers (litters 6-8) and from mothers with a high reproductive potential (over 10.1 piglets per litter at the age of 21 days) are characterized by better reproductive performance than the boars originating from short-living mothers and those with lower fertility.

Material and methods

Thd results were obtained at a reproductive farm with 240 Polish Large White (PLW) sows of the foundation stock. Out of 65 boars bred in the period of 3 years, eight were born in litters 6–8. A similar number of boars (n=8) was selected at random from the 3rd-5th reproductive cycle (litter) of mothers, and another 10 boars from litters 1–2. The boars were subjected to routine performance test at the age of ca. 180 days, by determining daily body weight gains since the day of birth till the day of performance test (adjusted to the age of 180 days), and by measuring backfat thickness using an ultrasound apparatus Piglog 105. Condition of housing and feeding were equal for all groups of pigs.

Depending on the succession of litter they were born in, the boars were divided into the following groups:

- group I – born in litters 1–2 (n=10),
- group II – born in litters 3–5 (n=8),
- group III – born in litters 6–8 (n=8).

In total, 26 boars (40% out of the 65 boars) were examined in the study. Out of those boars, 14 were originating from mothers characterized by high fertility computed based on the mean size of litter at the age of 21 days (consideration was given to all reared litters) which accounted for 11.60 piglets. The other 12 boars were originating from mothers with a lower fertility, in the case of which the mean litter size at the age of 21 days reached 9.16 piglets.

Depending on the average mothers' litter size, the boars were divided into the following groups:

- group *A* – litter size on day 21–10.1 and more piglets (n=14),
- group *a* — litter size on day 21–10 and less piglets (n=12).

This way of dividing boars into experimental groups was chosed to show the difference among the ones reared by sows of high or low fertility.

Ther esults of the performance test of boars at the age of ca. 180 days and reproductive performance of sows mated by those boars were compiled according to the above divisions. They included total fertility (live and dead piglets), number of piglets per litter at the age of 21 days, piglets' survivability, litter body weight and average body weigh of piglet at the age of 21 days (520 litters in total). In addition, calculations were made to determine the effect of different adjusted daily gains of young boars at the age of 180 days on reproductive performance of sows mated by those boars according to the following division:

1. group – 550g and less
2. group – 551–600g
3. group – 601–650g
4. group – 651–700g
5. group – 701–750g
6. group –751g and more.

The statistical analysis (SPSS v.10) was conducted with one- and two-way analysis of variance, considering the co-effect of the succession of litters the boars were born in (group I-III) and litter size at the age of 21 days (groups *A* and *a*). The significance of the differences was determined with the Tukey's test. No significant interaction was found between those factors. A coefficient of correlation was also calculated between fertility of boars' mothers and results of performance test of young boars – their sons, and reproductive performance of sows mated by those boars (516 pairs).

Results and discussion

Table 1 presents the characteristics of young boars in terms of their adjusted daily gains and backfat thickness depending on the analyzed factors.

The successive 6–8 litters of the boars (group III) had a statistically significantly (P<0.05) positive effect on reaching greater body weight gains, than the 3–5 litter (group II). The boars from group III were additionally displaying a tendency for lower adiposity. It is worth noting that mothers delivering at least 6 litters, the boars from group III were originating from, were characterized by a significantly smaller average litter size on day 21, compared to the mothers of boars from group I and II. This suggests that the sows with the longest productive life were those that were not exploited during rearing numerous progeny in litters 1–5. The sows from group III were also showing greater uniformity in litter size, than those from the other groups. However, the uniformity did not refer to performance test results of body weight gains adjusted to daily gains at the age of 180 days.

Table 1. **Characteristic of performance test of boars originating from mothers with different longevity and mother's litter size** (at 21 days)

Specification	No of boars	Litter size of boars mothers (g)	Daily gain (g)	Backfat thickness (mm)
Boar's successive birth litter				
1-2 (I group)	10	$10,7^{a} \pm 1,61$	640 ± 87	$13,7 \pm 2,9$
3-5 (II group)	8	$10,7^{a} \pm 1,19$	$602^{b} \pm 41$	$14,5 \pm 3,5$
6-8 (III group)	8	$9,9^{b} \pm 0,99$	$662^{a} \pm 117$	$12,6 \pm 4,1$
Mother litter size				
10 and less (a)	12	$9,2^{B} \pm 0,51$	$581^{B} \pm 59$	$13,9 \pm 2,3$
10.1 and more (A)	14	$11,6^{A} \pm 0,67$	$682^{A} \pm 81$	$13,3 \pm 4,2$
A, B-P<0.01;a, b - P<0,05				

The data in Table 1 indicate that the origin of young boars from a large liter (from A mothers) affected reaching higher adjusted daily gains (by 101 g) compared to the boars originating after mothers from group a (P<0.01). Therefore, no negative maternal effect was determined in this trait as well as in environmental conditions of a large reproductive farm, that had been recorded at this farm in the years 1979–1983 (Jarczyk et al.1992). In the present study, the boars originating from mothers of group *A* had their adjusted daily gains lower by 45 g (533 g) than the boars originating from mothers of group *a* (P<0.05). In the time interval of 15 years, the feeding of sows and young boars has improved; selection that is more precise was applied to reach the improvement in reproduction performance of sows as well as fattening and slaughter young boars and boar piglets and gilts. Thus, it may be concluded that the results presented depict more objectively the correlations between traits linked with animals' genotype. Hence, it may be stated that the origin of the boars from highly fertile mothers is linked with transmission of higher environmental resistance onto progeny, which in turn affects the presented in Table 1 greater adjusted daily gains of young boars from group A compared to the boars from group a.

Table 2 collates results of reproductive performance of sows mated by the boars originating from mothers characterized by different litter size and different longevity. The data presented therein indicate that the origin of boars after short- and long-living mothers – irrespective of the mother's litter size – had not effect on the fertility of sows mated with them (P=0.599). Attention should, however, be paid to a significant effect of the boars from group III on the number of piglets per litter at the age of 21 days, compared to the boars from group II (P=0.016), as well as to the survivability of piglets till the age of 21 days (P =0.024) and a higher body weight of litter at the age of 21 days (P=0.006). More distinct and statistically highly significantly positive effect occurred when the boars were originating from the highly fertile mothers from group A. It referred to the fertility of sows that were mated with the boars from group A (P<0.05), to the number of piglets in a litter at the age of 21 days, and to litter body weight at the age of 21 days (P<0.01). A tendency was also observed showing that the average body weight of 1 piglet from group A was higher by 0.15 kg than that of a piglet from group a, even though the piglets from group A originated from larger litters.

Important seems also the occurrence of positive effects of the co-action of traits linked with the origin of the boars from group III (6-8 litter) and from mothers of group *A* on the fertility of sows mated by those boars. It should be emphasized that the sows mated with those boars were characterized by fertility being higher by 1.84 piglets than the sows mated with the boars from group III a. The coupling effect of resistance traits linked with longevity and high fertility in the boars' mothers resulted in the highest number of piglets delivered by the sows from the subgroup III A, compared to all other groups examined (n=11.40). This preponderance was also tangible when compared to the number of piglets reared in a litter at the age of 21 days (n=10.56) and to the body weight of one piglet (6.77 kg), despite the highest average number of piglets in a litter. In addition, the III A group was characterized by the greatest uniformity of litter body weight and the average body weight of a piglet (±11.9 kg and ±0.36 kg, respectively). This suggests that the long-living and highly fertile sows transfer their traits linked with resistance also through the male progeny. Also the sows mated with the boars from group A and those originated from litters 1–2 and 3–5 were characterized by higher fertility, compared to the sows mated with the boars originating from mothers *a.*

Different results were recorded at the same farm more than ten years earlier when feeding conditions were poorer. A distinct negative maternal effect was then observed in the highly fertile sows, which affected a decrease in the reproductive value of boars (Jarczyk et al. 1992). The sows that were then mated by boars originating from mothers with the highest fertility *(A)* farrowed a lower number of piglets in a litter than the sows mated by the boars *a, i.e.* respectively 8.11 piglets/litter vs. 8.81 piglets (291 litters) and 9.76 piglets vs. 10.04 piglets/litter (283 litters). This has confirmed a common truth that already appropriate environmental conditions enable effective breeding work aimed at improving the reproductive traits of both sows and boars. This dependence was observed in small breeding farms (about 20 sows of the foundation stock), where the negative maternal effects were not recorded in the sows of highly fertile lines (Lewczuk et al.1999) and where the average litter size of sows at the age of 21 days in four successive generations reached 11.5 piglets; with an ascending tendency being maintained in that trait and in that period.

As is shown in Table 2, the worst results were noted for the sows mated by the boars originating from group II a.

Considerably poorer results of the progeny originating from litters 3–5 were also reported in earlier studies conducted at this farm (Jarczyk et al. 1999). The lowest body weight at the age of 84 days was noted for weaner piglets born in litters 3–5, and the highest one for those originating from litter 1 or litter 6 or successive litters (P<0.01). In addition, the percentage of piglets originating from highly fertile mothers (over 11 piglets per litter on average) at the age of 84 days accounted for 52%, compared to 18% from litters with 8–10 piglets and 30% originating from little fertile mothers (7.0 and less piglets per litter), in spite of the fact that the piglets of the less fertile sows were significantly heavier on day 1 after the birth (P<0.01).

A low number of works addressing the effects of reproductive traits of long-living mothers on the traits of reproductive performance of their sons may, to some extent, explain to conduct such an analysis on the example of relationships between long-living mothers and their daughters. Earlier investigations demonstrated a negative effect of gilts birth in the successive litter on the length of their productive life (Jarczyk and Konrad, 2000) or on the fertility of sows (Klocek et al., 1999 and Jarczyk and v.d. Steen, 1988). However, the positive effect of long-living mothers on fertility trait was revealed when

their daughters originated from the first litter (Jarczyk and Konrad, 2000). A short production life of daughters originating from long-living mothers (litter 5 and successive litters) was most probably due to deteriorated condition of the mothers in the successive reproductive cycles and to the depletion of energy reserves, which was indicated, among others, in a research by Esbenshede et al. (1986). This shows that the replacement sows originating from the 1st litters of long-living mothers had, and presumably have, environmental advantage over the sows originating from the same mothers but from successive litters. Hence, if feeding conditions are not optimal, it is difficult to achieve better production performance of progeny originating from long-living mothers, because then the negative maternal effect will eliminate the genetic advantage.

Table 2.**Reproductive results of sows mated by boars originating from litters of mothers with different longevity and litter size** (21days)

Group of boars successive litter birth	Group of boars' mothers	Number of litters	Litter size of sows mated by boars	No of piglets at age 21 days	Survival of piglets %	Litter weight at age 21 days kg	Body weight of piglet at age 21 days kg
I 1-2	a	113	10.07 ± 2.1	9.23 ± 2.3	91.6 ±14.1	61.7 ± 13.5	6.63 ± 0.74
	A	78	11.05 ± 2.2	10.37 ± 1.9	93.8 ± 8.2	70.3 ± 13.1	6.78 ± 0.40
	total a+A	191	10.47 ± 2.2	9.69 ± 2.2	92.6 ±11.4	65.2 ± 14.0	6.69 ± 0.62
II 3-5	a	60	9.95 ± 2.92	8.83 ± 2.5	88.7 ±17.8	58.3 ± 15.4	6.61 ± 0.64
	A	131	10.70 ± 2.4	9.67 ± 2.1	90.3 ± 12.6	64.8 ± 13.2	6.74 ± 0.71
	total a+A	191	10.46 ± 2.3	9.41^{b} ± 2.2	90.0^{b} ±14.6	62.8^{b} ± 14.2	6.70 ± 0.69
III 6-8	a	60	9.56 ± 2.2	8.96 ± 2.1	93.7 ±11.4	58.5 ± 13.5	6.57 ± 0.69
	A	74	11.40 ± 2.3	10.56 ± 1.7	92.6 ± 8.1	71.6 ± 11.9	6.77 ± 0.36
	total a+A	134	10.58 ± 2.4	9.85^{a} ± 2.0	93.1^{a} ±10.1	65.7^{a} ± 14.2	6.68 ± 0.54
Total:	a	233	9.91^{b} ± 2.2	9.06^{B} ± 2.3	91.4 ±14.4	60.0^{B} ± 14.0	6.61 ± 0.70
	A	283	10.98^{a} ± 2.4	10.10^{A} ± 2.0	92.0 ±10.4	68.1^{A} ± 13.2	6.76 ± 0.56
	Total a+A	516	10.50 ± 2.3	9.63 ± 2 .2	91.7 ± 12.3	64.5 ± 14.1	6.69 ± 0.63
a, b - P≤0,05 ;A,B- P≤0,01							

Knowing the dependence between complexes of performance traits also is an important issue in breeding practice (reproductive, fattening, slaughter). For this reason, periodical analyses of those traits should be conducted to enable the evaluation of correlations occurring between them (Milewska, 2008; Klimas and Klimiene 2012; Krupa and Wolf, 2013). Table 3 presents such correlations by showing coefficients of correlation between litter size of boars' mothers at the age of 21 days and reproductive traits of the sows mated by those boars. In majority of cases, the correlations observed between those traits were positive and statistically significant. Worthy of notice are statistically highly significant correlations between adjusted daily gains of the boars and sows fertility as well as between litter size and litter body weight on day 21 (r=0.184, r=0.273, r=0.309, respectively). The highest coefficient of correlation between the adjusted daily gains of the young boars at the age of 180 days and the weight of their litters (r=0.309) suggests that this trait is linked with genetic environmental resistance transferred by the boars to their progeny.

Table 3. **Correlation coefficients** (r) **between litter size** (21days) **of boars' mother as well the results of performance test of young boars and reproductive traits of sows mated by these boars**

Trait	1	2	3	4	5	6	7	8
1.Litter size of boars' mother	x	0.429***	-0.143**	0.182***	0.233***	0.067	0.279***	0.104*
2. Daily gain of tested boars		x	-0.305**	0.184**	0.273***	0.142**	0.309***	0.067
3. Backfat thickness of boars			x	-0.104*	-0.166**	0.062	-0.186***	-0.340
4. Fertility of sows mated by these boars				x	0.782***	0.287***	0.748**	-0.107
5. Litter size at the age of 21 day					x	0.353***	0.923***	-0.226***
6. Survivability of piglets						x	0.288***	-0.201***
7. Litter body weight at age of 21 days							x	0.150**
8. Piglet body weight at age of 21 days								x
* P≤0.05; **P≤0.01; ***P≤0.001								

If the daily body weight gains of young boars at the age of ca. 180 days are not so explicit prognostic indicator of their future reproductive value, it seems advisable to conduct an analysis of those correlations that would depict the varying effect of different values of that trait. Hence, in Table 4 data were provided for the reproductive traits of sows depending on the adjusted daily gains of boars mated to them (6 groups). The data presented therein indicate that almost all traits of the sows were improved along with boars achieving better results in adjusted daily gain up to the age of 180 days. Most of the differences were statistically significant. Though it did not refer to the average body weight of 1 piglet at the age of 21 days, it should be emphasized that the piglets originating from numerous litters, after the boars from groups 4, 5 and 6, were characterized by slightly higher body weights than the piglets from smaller litters after fathers from groups 1 and 2 gaining weight more slowly until the age of 180 days.

Table 4. **Effect of adjusted daily gains of young boars at the age of 180 days on results of reproductive performance of sows mated by these boars**

Group of boars (DG)	Number of litters	Litter size of sows mated by these boars	No of piglets at the age of 21 days	Survival of piglets %	Litter weight at the age of 21 days kg	Body weight of piglet at the age of 21 days kg
1(550 and<)	48	$9.68^{Bd} \pm 1.81$	$8.60^{Bd} \pm 2.28$	$89.2^{b} \pm 17.4$	$55.9^{B} \pm 13.6$	6.56 ± 0.58
2(551-600)	153	$9.78^{Bd} \pm 2.25$	$8.92^{Bd} \pm 2.20$	$91.9^{a} \pm 13.4$	$59.0^{B} \pm 14.3$	6.63 ± 0.65
3(601-650)	127	$10.64^{bc} \pm 2.54$	$9.75^{bc} \pm 2.08$	$92.0^{a} \pm 12.6$	$66.7^{A} \pm 13.4$	6.77 ± 0.72
4(651-700)	92	$11.08^{Aa} \pm 2.42$	$10.42^{Aa} \pm 1.75$	$94.5^{a} \pm 8.5$	$70.4^{A} \pm 11.8$	6.76 ± 040
5(701-750)	66	$11.15^{Aa} \pm 2.27$	$10.44^{Aa} \pm 1.83$	$93.9^{a} \pm 10.4$	$69.9^{A} \pm 12.3$	6.71 ± 0.78
6(751 and >)	34	$10.85^{Aa} \pm 2.06$	$10.41^{Aa} \pm 1.79$	$96.5^{a} \pm 6.8$	$69.9^{A} \pm 11.5$	6.71 ± 0.33
a,b - $P \leq 0.05$; A,B- $P \leq 0.01$						

In the issue, it may be concluded that:

- the origin of boars after highly fertile mothers affects increased fertility of sows mated by those boars. The advantage of the reproductive value of boars A over boars a occurred also within each subgroup I-III, yet the boars originating from long-living mothers (group III A) were achieving the best results. Assuming high fertility and longevity of sows as traits of the environmental resistance, it may be concluded that transmission of this resistance to progeny is also feasible by means of the boars as evidenced by the high coefficient of correlation between the adjusted daily gains of the young boars at the age of 180 days and the weight of their litters;
- young boars originating from highly fertile mothers were reaching higher adjusted daily gains than the boars originating from medium fertile mothers ($P<0.01$). Under conditions of the investigated farm, there was no negative maternal effect on results of performance test of the progeny;
- in this study, a dependence has repeated that the sows mated with boars born in litters 3–5 were characterized by statistically worse results of litter body weight ($P<0.05$) and piglets survivability, than the sows mated with boars from group I and III.

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