

CHARACTERISTICS OF THE REPRODUCTIVE PERFORMANCE OF PUŁAWSKA SOWS AND THEIR CROSSBREDS WITH POLISH LARGE WHITE (PLW) AND POLISH LANDRACE (PL) DEPENDING ON SELECTED PERFORMANCE TRAITS

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Abstract

The aim of the study was to determine the effect of selected differentiating factors: number of left teats (no.), number of right teats (no.), standardized daily gain (g), standardized backfat thickness (g), standardized carcass meat percentage (%) and the performance-test selection index value (pts.) on the reproductive performance of Puławska sows and their crossbreds obtained by crossing with Polish Large White (PLW) and Polish Landrace (PL) breeds. The factors included in the study were the number of piglets on days 1 and 21 of life (no.). The present study showed that crossing Puławska sows with Polish Landrace boars was the most favourable combination for obtaining high fertility and prolificacy. Puł×PL crossbred sows with at least 8 left teats and daily gains of at least 600 g gave birth to and reared more piglets both per litter and over the year. Puł×PL crossbred sows with a higher proportion of adipose tissue (at least 15.0 mm) and lower carcass lean content (at most 51.9%) were more fertile and prolific.

Keywords: sows, Puławska breed, crossbreds, reproductive performance, performance test

Introduction

Globalization affects all areas of life, including animal production and pig production in particular. The 21st century poses new challenges for pig breeders, especially with regard to proper housing, feeding and veterinary prevention. Pork production is currently becoming increasingly intensive and relies on highly muscled international transboundary breeds. This is a very dangerous trend that may lead to the elimination of national pig breeds. In the longer term, the new agricultural policy, the so-called European Green Deal, imposes new obligations on pig producers, including the need to maintain biodiversity at the highest possible level (Henning and Witzke, 2021). In Poland, genetic diversity in pigs is maintained through conservation breeding

of native breeds: Puławska, Żłotnicka White and Żłotnicka Spotted. These breeds are characterized by lower muscling and growth-rate parameters than international transboundary breeds or crossbreds, i.e. so-called hybrid animals offered by various commercial companies (Szyndler-Nędza et al., 2012).

At present, pig breeders and producers, taking into account the economic situation, market demand, consumer expectations and other factors, must pay increasing attention to the basic performance parameters of the pigs they keep, including reproductive traits of sows such as fertility, prolificacy and longevity (Rekiel et al., 2016; Babicz et al., 2022). Reproductive performance, as an important element of pig production, is of particular interest to breeders seeking to raise production to a higher breeding and economic level (Orzechowska and Mucha, 2009). In this respect, attention should be paid to the breeding and performance value of animals used for reproduction. The most effective method of breeding selection is performance testing of young breeding boars and gilts (Mucha et al., 2013). Although long-term breeding work has increased carcass leanness and growth rate, in gilts and sows this may contribute to a reduction in reproductive value (Bocian et al., 2010; Matysiak et al., 2010). On the other hand, increasing attention is being paid to the fact that sows may be reaching the limit of their reproductive capacity, expressed, among other traits, by the number of teats. Consequently, rearing large litters, often characterized by variable body weight and biological value, is becoming a greater challenge (Rekiel et al., 2013; Zaalberg et al., 2023). The aim of the study was to analyse the effects of selected fattening, slaughter and reproductive traits on the reproductive performance of Puławska sows and crossbred sows obtained by crossing this breed with PLW and PL breeds.

Material and methods

The analysis included three groups of sows, each comprising 100 females: Puławska (♀Puławska × ♂Puławska) and crossbreds (♀Puławska × ♂Polish Large White) and (♀Puławska × ♂Polish Landrace). The designations used in breeding and zootechnical records and presented in the tables were 4040, 4010 and 4020, respectively.

The sows were divided into groups according to the values of the parameters adopted as differentiating traits:

1. number of left teats (no.): group I: (≤ 7), group II: (≥ 8);
2. number of right teats (no.): group I: (≤ 7), group II: (≥ 8); $\leq$
3. standardized daily gain (g): group I: (≤ 599 g), group II: (≥ 600 g); ≤ 599 g, grupa II: (≥ 600 g);
4. standardized backfat thickness (mm): group I: (≤ 14.5), group II: (≥ 15.0); $\leq$
5. standardized carcass meat percentage (%): group I: (≤ 51.9), group II: (≥ 52.0); $\leq$
6. performance-test selection index value (pts.): group I: (≤ 121), group II: (≥ 122); $\leq$

Taking into account three consecutive reproductive cycles, the following reproductive performance indicators were calculated for each group: number of piglets born alive per litter (no.), number of piglets on day 21 of life (no.), number of male piglets on day 21 of life (no.) and number of female piglets on day 21 of life (no.). Data for the calculations were obtained from breeding and zootechnical records, including performance-test protocols, and from direct interviews with breeders at the farms where the sows were kept. The sows were fed according to the standards given by Grela and Skomiał (2020), taking their physiological status into account, i.e. early-pregnant, late-pregnant and lactating sows. Welfare conditions complied with the applicable requirements set out in the Regulation of the Minister of Agriculture and Rural Development of 15 February 2010 (Journal of Laws 2010 No. 56, item 344, as amended).

Statistical analysis was performed using STATISTICA version 6.0. Numerical values are presented as arithmetic means ($\bar{X}$), and variability is expressed as the standard deviation (SD).

Results

Table 1 presents the characteristics ($\bar{X}$ and SD) of the individual genetic groups of sows in terms of the number of piglets born and reared and the sex of piglets on day 21 of life. The largest litters were born and reared by 4020 crossbred sows, followed by purebred 4040 sows. The smallest litters occurred in 4010 crossbred sows. In all genetic groups, slightly more male than female piglets survived to day 21, although the differences did not exceed one piglet (0.6, 0.9 and 0.7 piglet for 4040, 4010 and 4020 sows, respectively).

Table 1. Number of piglets born and reared

Breed/crossbred	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	11,12	1,99	10,15	1,54	5,35	1,57	4,80	1,67
4010	11,04	1,94	10,00	1,46	5,44	1,69	4,56	1,86
4020	11,48	2,03	10,51	1,63	5,61	1,72	4,90	1,74

Tables 2 and 3 show changes in the number of piglets born and reared and their sex according to the number of teats in the left and right mammary lines, respectively, in sows of the individual genotypes. Sows with 8 or more teats in the left mammary line gave birth to and reared slightly more piglets. For the right mammary line, the highest numbers of piglets born and reared were recorded for 4020 sows with 7 or fewer teats, followed by 4010 sows with 8 or more teats. Among 4010 and 4020 sows with 8 or more right teats, 1.2 more male than female piglets were reared to day 21.

Table 2. Average number of piglets born and reared depending on the number of teats in the left mammary line in sows (head)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	11,08	2,06	10,09	1,53	5,29	1,61	4,80	1,67
4040	II	11,26	1,90	10,29	1,55	5,50	1,48	4,79	1,67
4010	I	10,95	1,92	9,95	1,45	5,46	1,67	4,49	1,85
4010	II	11,34	1,98	10,15	1,46	5,35	1,77	4,79	1,88
4020	I	11,48	2,16	10,49	1,68	5,61	1,76	4,87	1,80
4020	II	11,49	1,52	10,61	1,46	5,61	1,63	5,00	1,58

Table 3. Average number of piglets born and reared depending on the number of teats in the right mammary line in sows (head)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	11,14	2,05	10,19	1,58	5,39	1,65	4,80	1,79
4040	II	11,11	1,94	10,06	1,45	5,27	1,37	5,79	1,67
4010	I	10,86	1,97	9,86	1,43	5,28	1,61	4,58	1,89
4010	II	11,35	1,87	10,23	1,48	5,71	1,80	4,53	1,82
4020	I	11,69	2,10	10,70	1,74	5,60	1,76	5,10	1,75
4020	II	11,02	1,78	10,11	1,30	5,64	1,66	4,47	1,68

Tables 4, 5 and 6 present the number of piglets born and reared according to standardized daily gain, standardized backfat thickness and standardized carcass meat percentage, respectively, in sows of the individual genotypes. Purebred sows and 4010 sows with faster daily gain (600 g/day or more, group II) gave birth to and reared slightly more piglets per litter (0.3 and 0.2 more piglets born and 0.3 and 0.1 more piglets reared, respectively). In 4020 sows, the differences in the numbers of piglets born and reared were 0.1 and 0.2 piglet, respectively, in favour of the more slowly growing sows (group I). In addition, the more slowly growing 4010 and 4020 sows reared 1.0 and 1.1 more male piglets than female piglets, respectively.

Table 4. Average number of piglets born and reared depending on the standardized daily gain of gilts (g)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	10,99	1,95	10,02	1,45	5,29	1,59	4,47	1,68
4040	II	11,33	2,09	10,34	1,64	5,45	1,54	4,89	1,65
4010	I	10,97	1,98	9,97	1,47	5,48	1,73	4,49	1,85
4010	II	11,14	1,89	10,04	1,44	5,38	1,65	4,66	1,88
4020	I	11,52	2,01	10,61	1,64	5,84	1,79	4,77	1,83
4020	II	11,43	2,05	10,39	1,63	5,33	1,60	5,06	1,63

With regard to sow backfat thickness, purebred sows and 4020 crossbreds from group II (≥ 15 mm) gave birth to and reared more piglets than sows from the corresponding genetic groups with thinner backfat. This pattern was not observed in 4010 crossbred sows. Sows with thinner backfat gave birth to 0.1 more piglet but reared 0.1 fewer piglet than group II sows. In addition, 4010 sows from group I reared one more male piglet than female piglet.

Table 5. Average number of piglets born and reared depending on the standardized backfat thickness of gilts (mm)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	11,05	1,98	10,07	1,52	5,29	1,61	4,48	1,73
4040	II	11,27	2,20	10,26	1,58	5,30	1,41	4,96	1,61
4010	I	11,02	2,00	9,93	1,41	5,45	1,66	4,48	1,77
4010	II	10,95	1,73	10,05	1,52	5,45	1,64	4,60	1,99
4020	I	11,40	1,96	10,40	1,66	5,42	1,57	4,98	1,73
4020	II	11,80	2,34	10,61	1,76	5,70	2,06	4,91	1,67

Purebred sows and 4020 crossbreds with carcass meat percentage below 51.9% (group I) gave birth to and reared more piglets. The opposite pattern was found in 4010 crossbred sows, in which animals with carcass meat percentage above 52% gave birth to and reared more piglets. With regard to sex, the greatest differences between the numbers of male and female piglets reared were found in 4010 sows. Sows with carcass meat percentage below 51.9% reared 1.3 more male piglets than female piglets.

Table 6. Average number of piglets born and reared depending on the standardized carcass meat percentage of gilts (%)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	11,38	2,05	10,51	1,60	5,45	1,54	5,05	1,51
4040	II	11,11	2,01	10,12	1,53	5,34	1,58	4,77	1,68
4010	I	10,44	1,86	9,59	1,45	5,44	1,41	4,15	2,10
4010	II	11,11	1,94	10,04	1,45	5,44	1,72	4,60	1,83
4020	I	12,12	2,30	10,84	1,57	5,44	1,42	5,40	1,55
4020	II	11,37	1,96	10,46	1,64	5,64	1,77	4,82	1,76

Table 7 presents the average number of piglets born and reared and their sex according to the selection index of sows from the individual genetic groups. Sows from all genetic groups with a selection index value of 122 points or more had more piglets born and reared than sows with an index value of 121 points or less. No substantial differences in the numbers of male and female piglets reared were found in relation to the selection index.

Table 7. Average number of piglets born and reared depending on the selection index value of gilts (pts.)

Breed/crossbred	Group	No. of piglets born alive per litter		No. of piglets on day 21		No. of male piglets on day 21		No. of female piglets on day 21	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
4040	I	11,02	1,91	10,10	1,46	5,34	1,60	4,76	1,64
4040	II	11,46	2,28	10,30	1,75	5,38	1,50	4,92	1,75
4010	I	10,97	2,02	9,98	1,50	5,43	1,71	4,55	1,90
4010	II	11,22	1,72	10,04	1,35	5,45	1,66	4,59	1,76
4020	I	11,43	1,96	10,51	1,64	5,65	1,79	4,85	1,77
4020	II	11,61	2,20	10,53	1,64	5,51	1,57	5,02	1,68

Discussion

According to data from the Polish Pig Breeders and Producers Association “POLSUS” (2022), in 2021 the average litter size on day 1 was 12.28 piglets for the PL breed and 12.38 piglets for PLW. In the present study, the greatest number of piglets was born to Puł×PL crossbred sows and the smallest number to Puł×PLW sows (a difference of 0.44 piglet). Fertility of Puławska sows was intermediate (Table 1). This distribution is undoubtedly related to the principles of conservation breeding of the Puławska breed, in which selection aimed at increasing performance value is not carried out (Eckert et al., 2021). Litter size on day 21 is determined by many environmental factors (Kończak, 2017), but above all depends on actual fertility and piglet mortality during the suckling period. As shown by the data in Table 1, Puł×PL crossbred sows reared 0.51 more piglet than Puł×PLW crossbreds, while piglet losses in the individual groups did not exceed 10%, which is considered a desirable result in pig breeding and production (Grela and Skomiał, 2020). With regard to piglet sex, a small predominance of male over female piglets was observed in the litters, not exceeding 0.9 piglet.

One of the most important reproductive indicators in sows is the number of teats. Because this trait is highly heritable, it is included in the selection of both gilts and boars (Rekiel et al., 2013). According to Lechowska and Kusz (2003) and Lechowska and Augustyńska-

Prejsnar (2006), there is a positive correlation between teat number and sow fertility and milk production. When the effect of the number of teats in the left mammary line on litter size was compared (Table 2), the mean numbers of piglets born alive and reared were higher in all genetic groups of sows with at least 8 teats. In contrast, when the effect of the number of teats in the right mammary line was analysed (Table 3), an analogous relationship for the numbers of piglets born alive and reared was found only in Puł×PLW crossbred sows. Litters of purebred sows and crossbreds with PL were larger when their dams had 7 or fewer right teats.

The next differentiating trait analysed was daily gain of sows recorded during performance testing. Proper growth and development of gilts from birth until the beginning of reproductive use is a basic factor determining good reproductive results during their productive life (Matysiak et al., 2007). It should be emphasized, however, that rapid growth of gilts may adversely affect the length of their productive life. According to Sobczyńska and Blicharski (2014), more slowly growing gilts had a longer productive life. In turn, Eckert and Szyndler-Nędza (2018) showed that sows with greater body-weight gain from mating to farrowing had more piglets. In the present study, sows with high daily gains (≥ 600 g) generally gave birth to and reared more piglets; the exception was Puł×PL crossbred sows, although the differences were small (Table 4).

Backfat thickness is one of the traits defining the slaughter value of pigs. It is also of great importance in the reproductive performance of sows. Both excessive and insufficient adipose tissue disturb reproductive processes, which directly affects reproductive indicators in gilts and sows. According to Wićcek et al. (2023), backfat thickness is associated with the number of piglets reared. These authors reported that primiparous PLW sows with thinner backfat gave birth to 0.4 more piglet and reared 0.5 more piglet per litter than sows with thicker backfat. The average lifetime number of piglets born and reared to day 21 was higher by 0.3 and 0.4 piglet, respectively, in females with thinner backfat. In the present study, this relationship was confirmed only for Puł×PLW crossbred sows. Sows from the remaining genetic groups gave birth to and reared more piglets when the mean backfat thickness measured during performance testing was ≥ 15 mm.

In performance testing, the most important indicator of productive performance in gilts and boars is carcass leanness, and breeding work aimed at improving leanness in the national pig population has been conducted intensively since the 1990s. However, with regard to reproductive traits in Puławska sows, this type of selection is not considered beneficial (Szyndler-Nędza and Tyra, 2023). The present study also found an adverse effect of carcass meat percentage above 52% on actual fertility in Puławska sows and their crosses with PL; the differences between groups I ($\leq 51\%$) and II ($\geq 52\%$) were 0.27 and 0.75 piglet, respectively. In contrast, Puł×PLW crossbred sows with a higher carcass meat percentage, exceeding 52%, gave birth to 0.45 more piglet than sows with lower leanness. In this case, the high variability of performance traits obtained in crossbred animals should be emphasized, and a stronger heterosis effect may also occur in animals subjected to intensive selection for a specific production purpose (Piotruk and Rekiel, 2021). Szulc et al. (2013) showed that PLW sows with the highest carcass meat percentage ($>60\%$) gave birth to the greatest number of live piglets, i.e. 0.73 more piglet than sows with carcass meat percentage of 55% or less. With regard to sex, the present study showed that only Puł×PLW crossbred sows with carcass meat percentage of 51.9% or less reared more than one additional male piglet per litter compared with female piglets.

The overall performance-test indicator for gilts, which forms the basis for selection, is an index containing comprehensive information on the fattening and slaughter value of the animals (Szyndler-Nędza and Eckert, 2020). A high selection index is unquestionably found in animals from herds in which intensive breeding work is carried out. This applies to the PLW and PL breeds, but not to the Puławska breed, whose successive generations, in accordance with the conservation breeding programme, must not deviate from the adopted original breed

standard (Hammermeister et al., 2023); consequently, the selection index estimated for Puławska pigs is only indicative. The present results showed that in sows with a selection index exceeding 122 points, the numbers of piglets born alive and reared per litter were higher in all genetic groups. The highest values for these traits were obtained when Puławska sows were crossed with PL boars. With regard to sex, no substantial differences (greater than one piglet) in the numbers of male and female piglets reared were found between the analysed selection-index groups.

Conclusions

1. Crossing Puławska sows with Polish Landrace boars was shown to be the most favourable combination for obtaining high fertility and prolificacy.
2. Irrespective of genotype, sows with a greater number of teats in the left mammary line tended to give birth to and rear more piglets.
3. Puławska sows and Puł×PLW crossbred sows with daily gains above 600 g/day had larger litters on days 1 and 21 of life. The opposite results were obtained for Puł×PL crossbred sows.
4. Among the analysed genotypes, Puławska sows and Puł×PL crossbred sows with back-fat thickness above 15 mm and carcass meat percentage below 51.9% gave birth to and reared more piglets.
5. Irrespective of genotype, larger litter sizes on days 1 and 21 of life were characteristic of sows that achieved a selection index above 122 points.
6. No clear trend was found in litter sex distribution in relation to the analysed performance traits.

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**CHARACTERISTICS OF THE REPRODUCTIVE PERFORMANCE OF
PUŁAWSKA SOWS AND THEIR CROSSBREDS WITH POLISH LARGE WHITE
(PLW) AND POLISH LANDRACE (PL) BREEDS DEPENDING ON SELECTED
PERFORMANCE TRAITS**

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SUMMARY

The aim of the study was to determine the effect of selected differentiating factors: number of left teats, number of right teats, daily standardized gain (g), standardized backfat thickness (g), carcass meat percentage, and performance test selection index value (pts.) on the reproductive performance of Puławska sows and their hybrids obtained from the crossing with PLW and PL breeds. Treatment factors were the number of piglets at 1 and 21 days of age. It has been shown that crossing sows of the Puławska breed with boars of the PL breed is the most beneficial for obtaining high fertility and prolificacy. Puł×PL crossbred sows with ≥ 8 left teats and daily gains of ≥ 600 g gave birth to and raised more piglets per litter and per year. Puł×PL hybrids with a higher proportion of adipose tissue (≥ 15.0 mm) and lower meatiness ($\leq 51.9\%$) were more fertile and prolific.

Keywords: sows, Puławska breed, crossbreds, reproductive performance, performance test