

PRODUCTION RESULTS OF PUŁAWSKA SOWS DEPENDING ON THEIR PERFORMANCE TEST RESULTS

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Abstract

The aim of the study was to determine the effect of interactions between traits included in the performance testing of young Puławska gilts on the number of piglets born and reared during their reproductive life. The analyses were performed on a dataset of 2,722 Puławska gilts with complete information from fattening and slaughter performance testing and reproductive performance results. The data came from 71 breeding herds and covered parities 1 to 15. The information collected included body weight on the day of testing (kg), daily gain standardized to 180 days of age (g/day), backfat thickness measured at points P2 and P4 (mm), mean backfat thickness (mm) $((P2+P4)/2)$, loin eye height measured at point P4 (P4M) (mm), carcass meat percentage (%), the number of piglets born alive (head), and the number of piglets at 21 days of age (head) for 12,665 purebred litters. Multivariate statistical analysis including all factors considered in the fattening and slaughter performance testing of young breeding gilts showed that gilts tested at a body weight above 96 kg, with carcass meat content of up to 59.9% (classes O, R, U and E) and daily gains of up to 799 g/day, gave birth to and reared the largest number of piglets per litter. Gilts with daily gains above 800 g/day achieved good reproductive performance only when their meatiness did not exceed 54.9% (class U). Females weighing more than 116 kg and with meatiness of 60% or more (class S) gave birth to a satisfactory number of piglets, but reared them less successfully than gilts with lower meatiness.

Keywords: pigs, Puławska breed, performance testing, piglet production

Introduction

The Puławska breed, one of the oldest pig breeds maintained in Poland, is covered by a genetic resources conservation programme. In addition to increasing the number of animals, the main

objectives of the programme include maintaining the existing genetic distinctiveness and within-breed variability and preserving the valuable traits of this breed at an unchanged level. These objectives are pursued through individual mating selection while applying principles intended to limit increases in inbreeding, together with moderate selection based on performance trait indices (Hammermeister et al., 2021). Changes in the performance indices of young boars, gilts and sows have been monitored over the last several years (Szyndler-Nędza et al., 2025). Monitoring of sow reproductive performance has shown a gradual decrease in the number of piglets born in the Puławska breed since 2016. Analysis of additional traits, i.e. the weight of purebred piglets and litters at birth and at weaning, indicated some fluctuations in these parameters, but no adverse trends were observed. Puławska sows covered by the programme were characterized by good maternal care and milk yield (they reared piglets weighing on average 5 kg). Monitoring of fattening and slaughter traits of Puławska gilts in 2016–2024 also indicates a gradual reduction in fatness and an increase in muscularity. Therefore, it was decided to verify the hypothesis that the observed changes in fattening and slaughter traits of Puławska gilts have a significant effect on the reduction in the number of piglets born. The influence of sow fattening and slaughter traits on reproduction has been analysed by many authors. Bečková et al. (2005), in Landrace pigs, and Roongsitthichai et al. (2013), in F1 crossbreeds (Landrace × Yorkshire), showed that gilts with faster daily gains produced more piglets per litter than females with slower growth. Roongsitthichai et al. (2013) further showed that gilts weighing more than 150 kg when introduced into breeding produced more piglets per litter than lighter gilts (136–140 kg). Results concerning the effect of carcass meat percentage in gilts at selection on their reproductive performance are less conclusive. Kawęcka et al. (2009), in gilts of paternal line 990, estimated a statistically significant negative effect of high carcass meat content in young gilts on the number of piglets born in three successive litters. Opposite results were obtained by Grzyb et al. (2007), who found no effect of carcass meat percentage (ranging on average from 52.61% to 59.67%) in Polish Landrace gilts on the number of piglets born. These findings indicate that meatiness measured during performance testing is breed-specific and its use for assessing female reproductive ability should be determined separately for each breed. Knecht et al. (2020), analysing changes in muscularity of maternal-line sows (PL, PLW, PL×PLW) during three successive reproductive cycles, showed that lower muscularity and greater fatness on the day of insemination improved reproductive performance indices. Similarly, Babicz et al. (2022), studying Puławska gilts from five farms in the Lublin region, found that females with meatiness below 55% and backfat thickness above 16 mm had better reproductive performance than gilts with greater meatiness and lower fatness. 2009

The aim of the study was to determine the effect of interactions between traits included in the performance testing of Puławska gilts on the number of piglets born and reared during their reproductive life.

Material and methods

Experimental material

The analyses were performed on a dataset of 2,722 Puławska gilts covered by the conservation programme and having complete information from fattening and slaughter performance testing as well as reproductive performance results. The data came from 71 breeding herds and covered parities 1 to 15. In accordance with the current methodology (Szyndler-Nędza, 2025), the animals underwent in vivo fattening and slaughter performance testing and reproductive evaluation. The dataset containing the results of individual performance evaluations was provided by the Polish Pig Breeders and Producers Association “POLSUS”. The data collected as part of fattening and slaughter performance testing included: body weight on the day of testing (kg), daily gain standardized to 180 days of age (g/day), backfat thickness measured on the back at

points P2 and P4 (mm) and standardized to 110 kg body weight, mean backfat thickness (mm) $((P2+P4)/2)$, loin eye height measured at point P4 (P4M) (mm) and standardized to 110 kg body weight, and carcass meat percentage (%) standardized to 180 days of age. Information on the number of purebred piglets born and reared in successive litters was added to the performance-testing data. In total, the dataset contained information on the number of piglets born alive (head) and the number of piglets at 21 days of age (head) for 12,665 purebred litters.

Statistical analyses

To determine the effect of selected factors on sow production results, three groups of factors were created: body-weight groups, daily-gain groups and meatiness groups. These groups were established on the basis of the mean and standard deviation of the individual traits.

The body-weight group ranges were as follows: BW1 – up to 95.7 kg (1,986 observations), BW2 – from 95.8 kg to 115.9 kg (8,947 observations), BW3 – from 116 kg to 135.9 kg (1,682 observations), BW4 – from 136 kg (50 observations).

The daily-gain group ranges were as follows: G1 – up to 519 g/day (1,952 observations), G2 – from 520 to 659 g/day (8,728 observations), G3 – from 660 to 799 g/day (1,922 observations), G4 – 800 g/day and above (63 observations).

Meatiness groups were created according to the ranges used in the SEUROP pig carcass classification. Group S ($\geq 60\%$) included 904 observations, group E (55.0–59.9%) – 6,191, group U (50.0–54.9%) – 4,829, group R (45.0–49.9%) – 684, and group O ($< 44.9\%$) – 57 observations.

The effect of all factor groups on reproductive, fattening and slaughter performance was determined using analysis of variance with two- and three-way interactions according to the GLM procedure. Fixed effects were body-weight group (1–4), daily-gain group (1–4), and meatiness group (1–5); random effects were parity group (1–3), herd (71), and sow year of birth (2001–2019). Differences between trait means were estimated using the LSD test at $P < 0.05$. Statistical analyses were performed using STATISTICA v. 12 (StatSoft, Inc. 2014. STATISTICA data analysis software system, www.statsoft.com).

Results

Tables 1–3 present the simultaneous effects of two traits, whereas Tables 4 and 5 show the effects of three traits included in gilt performance testing on the number of piglets born and reared to 21 days of age. When the effects of daily gain and gilt body weight were analysed simultaneously, gilts tested at a body weight up to 95.9 kg (BW1), irrespective of daily gain, had statistically significantly ($P \leq 0.05$) the poorest results for the number of piglets born and reared compared with gilts tested at higher body weights (Table 1). A statistically significant effect of daily gain on the number of piglets born and reared was found only in gilts tested at a body weight of 96–115.9 kg (BW2). Within this group, gilts with daily gains of 660–799 g (G3) and 520–659 g (G2) had significantly the highest numbers of piglets born ($G3 > G2 > G1$, $P \leq 0.05$) and reared ($G2$, $G3 > G1$, $G4$, $P \leq 0.05$). Among all groups analysed, the highest numbers of piglets born and reared were recorded in gilts with daily gains of 660–799 g (G3) that were tested at a body weight of 136 kg or more (BW4).

Table 1. Effect of interaction between gilt body weight and her daily weight gain on the number of piglets born and reared

			Daily gain group (g/day)			
			P1 up to 519	P2 from 520 to 659	P3 from 660 to 799	P4 800 and above
Number of piglets born						
Body weight group (kg)	MC1	up to 95.9	10,1±0,1 x	10,0±0,1 x	10,0±0,3 x	-
	MC2	from 96 to 115.9	10,4±0,1 ay	10,7±0,0 by	10,9±0,1 cy	10,6±0,3
	MC3	from 116 to 135.9	10,0	10,7±0,1 y	10,8±0,1 y	11,3±0,5
	MC4	136 and above	-	11,2±0,5	11,8±0,2 z	-
Number of piglets reared						
Body weight group (kg)	MC1	up to 95.9	9,1±0,1 ax	9,1±0,1 ax	8,6±0,3 bx	-
	MC2	from 96 to 115.9	9,3±0,1 ay	9,5±0,0 by	9,6±0,0 by	8,8±0,3 ax
	MC3	from 116 to 135.9	8,0	9,6±0,1 y	9,6±0,1 y	10,3±0,3 y
	MC4	136 and above	-	10,5±0,2	10,2±0,2 y	-

Means in rows with different lowercase letters (a, b) differ at $P \leq 0.05$.

Means in columns with different lowercase letters (x, y) differ at $P \leq 0.05$.

Analysis of the next two traits affecting reproductive performance showed that gilts with meatiness in classes R, U and E, tested at a body weight below 95.9 kg (BW1), had significantly the lowest numbers of piglets born and reared compared with gilts weighing up to 135.9 kg (BW1<BW2, BW3; $P \leq 0.05$) (Table 2). In contrast, gilts in meatiness class E weighing more than 136 kg had the highest numbers of piglets born and reared within this meatiness class (BW1<BW2, BW3<BW4; $P \leq 0.05$). Among gilts in meatiness class S, those tested at a body weight up to 115 kg (BW2) had significantly the lowest numbers of piglets born and reared compared with gilts weighing up to 135.9 kg (BW2<BW3, $P \leq 0.05$).

When the effects of daily gain and gilt meatiness on the number of piglets born and reared were analysed simultaneously, a statistically significant effect of daily gain was found only in gilts in meatiness classes U and E (Table 3). In meatiness class U, gilts with daily gains of 800 g/day and above (G4) had the highest number of piglets born among gilts in that class (G1U<G2U<G3U, G4U; $P \leq 0.05$). In class E, gilts from group G3 had the highest numbers of piglets born and reared compared with the other gilts in this meatiness class (piglets born: G1E<G2E, G4E<G3E; $P \leq 0.05$; piglets reared: G4E<G1E<G2E, G3E; $P \leq 0.05$).

The effect of gilt carcass meat percentage on reproductive performance was evident in all daily-gain groups. Gilts with daily gains up to 659 g/day (G1, G2) and meatiness in classes E and S had significantly fewer piglets born per litter than gilts in meatiness class O in group G1 (G1S<G1O; $P \leq 0.05$) and classes R and U in group G2 (G2E, G2S<G2R, G2U; $P \leq 0.05$). Gilts from group G3 with meatiness in classes R, U, E and S gave birth to and reared significantly fewer piglets than gilts in meatiness class O ($P \leq 0.05$). Gilts from group G4 (800 g/day and above) with meatiness from 45% to 54.9% (R and U) gave birth to and reared the most piglets compared with gilts with meatiness from 55% to 59.9% (E).

Table 2. Effect of interaction between gilt body weight and her meatiness on the number of piglets born and reared

			Meatiness group (%)*				
			O	R	U	E	S
Number of piglets born							
Body weight group (kg)	MC1	up to 95.9	11,0±1,0	10,0±0,4 x	10,1±0,1 x	10,0±0,1 x	10,5±0,3
	MC2	from 96 to 115.9	11,4±0,3 b	10,8±0,1 by	10,8±0,0 by	10,6±0,0 ay	10,1±0,1 cx
	MC3	from 116 to 135.9	11,0±0,8	11,0±0,1 y	10,9±0,1 by	10,6±0,1 ay	10,7±0,1 y
	MC4	136 and above	-	-	11,2±0,5	11,9±0,2 z	10,3±0,7
Number of piglets reared							
Body weight group (kg)	MC1	up to 95.9	9,5±1,5	9,0±0,3 x	9,2±0,1 x	9,0±0,1 x	9,3±0,3
	MC2	from 96 to 115.9	10,4±0,2 d	9,7±0,1 by	9,7±0,0 by	9,4±0,0 ay	8,9±0,1 cx
	MC3	from 116 to 135.9	10,2±0,6 ab	9,9±0,1 by	9,8±0,1 by	9,5±0,1 ay	9,3±0,1 ay
	MC4	136 and above	-	-	10,1±0,4	10,4±0,1 z	9,0±0,6

*Percentage meat content in groups: O – ≤ 44.9%, R – from 45% to 49.9%, U – from 50% to 54.9%, E – from 55% to 59.9%, S – ≥ 60%.

Means in rows with different lowercase letters (a, b) differ at $P \leq 0.05$.

Means in columns with different lowercase letters (x, y) differ at $P \leq 0.05$.

Table 3. Effect of interaction between daily gain and sow meatiness on the number of piglets born and reared

			Meatiness group (%)*				
			O	R	U	E	S
Number of piglets born							
Daily gain group (g/day)	P1	up to 519	12,0±0,6 a	10,3±0,5	10,4±0,1 x	10,3±0,1 x	10,1±0,2 b
	P2	from 520 to 659	10,2±0,5	10,9±0,1 a	10,7±0,0 ay	10,5±0,0 by	10,4±0,1 b
	P3	from 660 to 799	11,6±0,3 a	10,7±0,1 b	10,9±0,1 bz	10,8±0,1 bz	10,3±0,4 b
	P4	800 and above	-	11,0±0,9	11,3±0,3 az	9,6±0,7 bxy	-
Number of piglets reared							
Daily gain group (g/day)	P1	up to 519	10,2±0,6	9,3±0,4	9,4±0,1 ax	9,2±0,1 bx	8,9±0,1 b
	P2	from 520 to 659	9,6±0,3	9,7±0,1 a	9,6±0,0 ay	9,4±0,0 by	9,1±0,1 c
	P3	from 660 to 799	10,5±0,3 a	9,6±0,1 b	9,6±0,1 by	9,5±0,1 by	8,7±0,5 c
	P4	800 and above	-	10,3±0,9 a	9,9±0,2 a	7,6±0,7 bz	-

*Percentage meat content in groups: O – ≤ 44.9%, R – from 45% to 49.9%, U – from 50% to 54.9%, E – from 55% to 59.9%, S – ≥ 60%.

Means in rows with different lowercase letters (a, b) differ at $P \leq 0.05$.

Means in columns with different lowercase letters (x, y) differ at $P \leq 0.05$.

When the simultaneous effect of three performance-test traits on the number of piglets born and reared was analysed (Tables 4 and 5), the poorest reproductive performance was found in sows with meatiness of 60% or more, tested at a body weight of 96–115.9 kg (BW2) and achieving daily gains up to 799 g/day (G1–G3). These animals gave birth to and reared statistically significantly fewer piglets than sows in corresponding daily-gain groups with lower meatiness. It was also found that BW2 sows with meatiness of 55–59.9% (E) and daily gain above 800 g/day gave birth to and reared statistically significantly fewer piglets than sows with meatiness of 50–54.9% (U). Moreover, highly muscled sows (S) tested at a body weight of 116–135.9 kg (BW3) and daily gains of 520–799 g/day (G2 and G3) reared statistically significantly fewer piglets than sows with lower meatiness. Sows tested at a body weight up to 95.9 kg, irrespective of daily gain and meatiness, had low values for the number of piglets born and reared. In this group, sows with meatiness from 50% to 60% and above (U, E, S) and daily gain up to 519 g/day gave birth to statistically significantly more piglets than sows with meatiness of 45–49.9% (R).

Table 4. Effect of interaction between body weight, daily gain, and meatiness of sows on the number of piglets born

		MC1 up to 95.9					MC2 from 96 to 115.9					MC3 from 116 to 135.9					MC4 136 and above				
Meatiness		O	R	U	E	S	O	R	U	E	S	O	R	U	E	S	O	R	U	E	S
Gain	1	12,0	8,4 b	10,2 a	10,0 a	10,4 a	12,0 a	10,8	10,5 a	10,4	10,1 b	-	-	-	10,0	-	-	-	-	-	-
	2	-	10,6	10,0	10,0	11,2	10,6	10,9 a	10,8 a	10,6 b	10,1 c	9,0	11,1	10,8	10,6	10,7	-	-	-	11,2	-
	3	10,0	9,0	10,5 a	9,4 b	-	11,6 a	10,8	10,9	10,8	10,0 b	11,9	10,7	11,0	10,7	10,5	-	-	11,2	12,1	10,3
	4	-	-	-	-	-	-	-	11,1 a	9,1 b	-	-	11,0	11,6	10,4	-	-	-	-	-	-

Gain 1 – up to 519 g/day; 2 – from 520 to 659 g/day; 3 – from 660 to 799 g/day; 4 – 800 g/day and above.

S – from 60%, E – from 55% to 59.9%, U – from 50% to 54.9%, R – from 45% to 49.9%, O<44.9%.

Table 5. Effect of interaction between body weight, daily gain, and meatiness of sows on the number of piglets reared

		MC1 up to 95.9					MC2 from 96 to 115.9					MC3 from 116 to 135.9					MC4 136 and above				
Meatiness		O	R	U	E	S	O	R	U	E	S	O	R	U	E	S	O	R	U	E	S
Gain	1	11,0	7,9	9,3	9,0	9,2	10,0	9,7 a	9,5 a	9,3 a	8,8 b	-	-	-	8,0	-	-	-	-	-	-
	2	-	9,4	9,2	9,1	10,2	10,0	9,7 ab	9,7 a	9,5 b	9,0 c	8,7	9,8	9,9 a	9,5 b	9,3 b	-	-	-	10,5	-
	3	8,0	8,5	8,9	8,1	-	10,5a	9,6 b	9,7 b	9,6 b	9,1 b	10,9 a	10,0 a	9,7 a	9,5 a	8,5 b	-	-	10,1	10,3	9,0
	4	-	-	-	-	-	-	-	9,4 a	6,7 b	-	-	10,3	10,5	9,4	-	-	-	-	-	-

Gain 1 – up to 519 g/day; 2 – from 520 to 659 g/day; 3 – from 660 to 799 g/day; 4 – 800 g/day and above.

S – from 60%, E – from 55% to 59.9%, U – from 50% to 54.9%, R – from 45% to 49.9%, O<44.9%.

Discussion

The number of piglets born per litter is influenced by a range of genetic and environmental factors. Genetic factors include breed as well as the sow line within a breed, characterized by a specific combination of single-nucleotide polymorphisms (SNPs) that, under favourable environmental conditions, may predispose a female to produce, for example, more piglets per litter (Terman and Kumalska, 2012; Szyndler-Nędza et al., 2016; Babicz et al., 2020). Among environmental factors, appropriate nutrition of sows throughout the reproductive cycle is particularly important, as it ensures good body condition, including adequate carcass fatness, and prepares the animals for colostrum and milk production (Surasak et al., 2012; Hansen et al., 2012; Loisel et al., 2014; De Rensis et al., 2005; Tummaruk et al., 2007; Szyndler-Nędza et al., 2017). Many authors analysing the effect of fattening and slaughter traits on sow reproductive performance have concluded that selection aimed exclusively at improving fattening and slaughter traits may contribute to poorer reproductive performance (Tummaruk et al., 2001; Holm et al., 2004; Grzyb et al., 2007; Matysiak et al., 2010; Knecht et al., 2020). Szyndler-Nędza and Tyra (2023) likewise showed that, in Puławska gilts, lower body weight and daily gain combined with increased meatiness adversely affected reproductive performance, particularly in first litters. Those authors based their conclusions on separate analyses of the effect of each factor on the number of piglets born and reared. From the standpoint of breeding practice, however, it is more useful to determine whether two or three performance-test traits can be used simultaneously as markers of sow reproductive performance.

Analysis of the effects of body weight and daily gain at gilt performance testing on the number of piglets born and reared showed that, irrespective of daily gain, a body weight up to 95.9 kg at testing was associated with poorer reproductive performance. A direct cause may be the excessively early introduction into breeding of gilts selected on the basis of their performance-test results. This hypothesis and the results obtained are consistent with findings of other authors, who showed that greater sow body weight at first insemination (above 139 kg) increased the number of piglets born in second and subsequent litters (Lesskiu et al., 2015; Roongsitthichai et al., 2013). Poorer reproductive results in sows with low body weight at first mating are probably due to insufficient protein and fat reserves needed for reproduction (Rekiel et al., 2011; Lesskiu et al., 2015).

Analysis of body weight and carcass meat percentage showed that increasing body weight at testing in gilts from meatiness classes R, U, E and S was associated with increased numbers of piglets born and reared. At the same time, in gilts weighing 96–115 kg (BW2), increasing meatiness to 55% or more (E and S) reduced the number of piglets born and reared. These results are consistent with those of Kawęcka et al. (2009) and Knecht et al. (2020) and may indicate that inadequate preparation of gilts for breeding can negatively affect lifetime piglet production. Accumulation of an appropriate amount of subcutaneous fat appears to support normal energy metabolism during lactation and maintenance of good reproductive condition in successive cycles, thereby contributing to longevity. Higher meatiness, although indicative of high slaughter value, may at the same time pose a potential risk to sow condition during subsequent lactations and lead to earlier culling.

Analysis of the effects of daily gain and meatiness on the number of piglets born and reared showed that increasing daily gain in gilts with meatiness classes U and E was associated with increased numbers of piglets born and reared. Walkiewicz et al. (2004), also studying the Puławska breed, found that the greatest numbers of piglets were born to sows with daily gains above 500 g/day. These results indicate that excessively slow body-weight gain in young Puławska gilts (up to 500 g/day) may negatively affect lifetime piglet production. A similar tendency has been observed in other breeds. Grzyb et al. (2007) and Roongsitthichai et al.

(2013) showed that sows with daily gains above 650 g/day, compared with slower-growing sows (<509 g/day), achieved better reproductive performance in successive litters.

Based on multivariate statistical analysis including all factors considered in the fattening and slaughter performance testing of young breeding gilts, it was found that gilts tested at a body weight above 96 kg, with carcass meat content up to 59.9% (classes O, R, U and E) and daily gains up to 799 g/day, gave birth to and reared the largest number of piglets per litter. Gilts with daily gains above 800 g/day on the day of testing achieved good reproductive performance only when their meatiness did not exceed 54.9% (class U). Gilts with meatiness of 60% or more (class S) gave birth to a satisfactory number of piglets only when their body weight at testing exceeded 116 kg. However, these animals reared piglets less successfully than gilts with lower meatiness.

Conclusions

The results indicate that the most favourable reproductive performance was achieved by gilts that, on the day of testing, weighed 96 kg or more, had a daily gain of up to 800 g/day, and had carcass meat content within class E (55–59.9%). Therefore, in the Puławska breed covered by the conservation programme, it is recommended that gilts meeting these criteria should be given priority when selecting females as replacement sows.

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PRODUCTION RESULTS OF PUŁAWSKA SOWS DEPENDING ON THEIR PERFORMANCE TEST RESULTS

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SUMMARY

The aim of the study was to determine the effect of interactions between the traits included in the live evaluation of young Puławska gilts on the number of piglets born and reared during their reproductive life. The analyses were performed on a data set of 2,722 Puławska gilts with complete information from fattening and slaughter assessments and reproductive performance results. The data came from 71 breeding herds, from parities 1 to 15. The information collected included: body weight on the day of evaluation (kg), daily weight gain standardized to 180 days of age (g/day), backfat thickness measured at points P2 and P4 (mm), average backfat thickness (mm) $((P2+P)/2)$, loin eye height measured at point P4 (P4M) (mm), carcass meat percentage (%), number of piglets born alive (head) and number of piglets at 21 days of age (head) for 12,665 purebred litters. Based on a multivariate statistical analysis involving all factors taken into account in the fattening and slaughter evaluation of young breeding gilts, it was found that gilts subjected to live evaluation with a body weight above 96 kg and characterized by a carcass meat percentage of up to 59.9% (ORUE) and daily weight gains of up to 799 g/day gave birth to and reared the largest number of piglets in the litter. Gilts with a daily weight gain on the day of evaluation of over 800 g/day achieved good reproductive parameters only when they had a meatiness of up to 54.9% (class U). Gilts with meatiness of 60% and above (class S) only gave birth to a satisfactory number of piglets when their body weight on the day of evaluation was above 116 kg. However, these animals reared piglets less well than gilts with lower meatiness.

Keywords: pigs, Puławska breed, performance testing, piglet production