The influence of fattening and slaughter traits on reproduction in Polish Large White sows

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Abstract

The aim of the study was to determine the influence of growth rate, back fat thickness, loin eye height and meatiness on the reproductive performance of sows based on the first two reproduction cycles. This study was conducted on 348 sows of the Polish Large White breed maintained in farm conditions. It was observed that the sows from the group with the lowest weight gains (≤600 g) were characterised by the latest age of first farrowing, which was 374 days, and the lowest number of live born piglets in a litter (12.13 heads). Statistical analysis also demonstrated that females from the group with the thickest back fat (>15 mm) bore the lowest number of piglets born in a litter (11.87 live-born piglets). The study also showed that females from the group with the lowest standardised meatiness (%) had the least numerous litters: 11.87 live-born piglets. It was observed that females from the group with the thickest back fat (>15 mm) bore the lowest number of piglets born in a litter (11.87 heads). Statistical analysis also demonstrated that females from the group with the thickest back fat (>15 mm) bore the lowest number of piglets born in a litter (11.87 live-born piglets). In turn, the sows with the lowest weight gains from the group with the lowest weight gains (≤600 g) were characterised by the latest age of first farrowing, which was 374 days, and the lowest number of live born piglets in a litter (12.13 heads). Statistical analysis also demonstrated that females from the group with the thickest back fat (>15 mm) bore the lowest number of piglets born in a litter (11.87 live-born piglets). It was observed that females from the group with the lowest standardised meatiness (%) had the least numerous litters: 11.87 live-born piglets (on average 11.47 heads), and the difference between this group and the others was highly significant.

Introduction

Currently, the average meatiness of the Polish Large White (PLW) breed assessed in vivo reaches 58.50% for gilts (Eckert and Szczylnder-Nęzda, 2011). Together with the Landrace, the PLW, similar to the Italian Large White (ILW) in Italy, is the basic maternal breed of pigs reared in Poland (Dall’Olio et al., 2011; Schwarz et al., 2009). In the year 2010, sows of the Polish Large White breed accounted for 33.01% of the Polish national pig population (Orzechowska and Mucha, 2011).

Particular breeds demonstrate different levels of reproduction traits (Pietrola et al., 2006; Franci and Pugliese, 2007; Antunović et al., 2009; Szulc et al., 2011; Skrzypczak et al., 2012). This suggests that genetic improvement is possible (Rothschild, 1996). Various authors emphasise that reproduction traits should be included in the development of breeding strategies directed at improving fattening and slaughter traits (Kuehn et al., 2009). Numerous studies have demonstrated the relationships between these groups of traits (Tummaruk et al., 2001; Čechova and Tvrdoň, 2006; Mijatović et al., 2009; Tummaruk et al., 2009). According to some researchers, an improvement in meatiness and a decrease in back fat thickness cause deterioration of some traits of the reproduction performance of sows (Kuehn et al., 2009). Different results were obtained by Čechova et al. (2000) and Mijatović et al. (2009). They reported that increasing meatiness does not have a negative influence on the number of piglets born and reared. In turn, Čechova and Tvrdoň (2002) observed that an increase in daily gain rate significantly influences the increase in the number of piglets born and reared. Opinions differ among researchers concerning the influence of some fattening and slaughter traits on reproduction traits and this prompts further studies into this.

The aim of the study was to determine the influence of growth rate, back fat thickness, loin eye height and meatiness on the reproductive performance of sows estimated on the basis of the first two reproduction cycles.

Materials and methods

The study was conducted in 2010-2011 on 348 sows of the Polish Large White breed (PLW) maintained in farm conditions. The animals were fed complete feed mixtures prepared on the farm. The mixtures were balanced according to Polish standards of animal feeding. The basic composition of the mixtures is presented in Table 1.

The gilts were reared in collective pens where they had access ad libitum to fodder. Pregnant and lactating sows were fed in a restrictive manner. Fodder dosing was performed using batch feeders, where the dose of fodder was measured individually for each sow. Pregnant sows were given approximately 3 kg of mixture at two different feeding times. Sows rearing piglets were fed the mixture for lactating sows. During that period they were fed three times per day. The amount of fodder for particular individuals was adjusted individually, taking into account the condition of the sow and the number of piglets in a litter. The fodder was prepared using a strip horizontal mixer that ensured proper mixing and homogeneity of the prepared mixture.

The animals were subjected to in vivo assessment at the age of 150-210 days according to methodology approved in Poland, using a PIGLOG 105 ultrasound apparatus on the right side of the animal (Eckert and Zak, 2011). The following fattening and slaughter traits were determined: body weight of animals on the day of assessment (kg), standardised back fat thickness at points P2 and P4 (mm), average standardised back fat thickness from two measurements (mm), standardised loin eye height, and meatiness (%).

Back fat thickness at points P2 and P4 (mm), average back fat thickness from two measurements (mm), and loin eye height is standardised for 110 kg of body weight. Evaluation of meatiness based on standardised
The reproduction performance of the sows was assessed based on the first two reproduction cycles. The following traits were taken into account: number of live-born piglets in a litter up to day 21 of life (heads), number of piglets reared from a litter (heads), number of piglets reared from a litter up to day 21 of life (heads). The assessment was made on 696 purebred PLW x PLW litters in total. The age of the first farrowing of the females and the inter-farrowing period (days) were also determined. Statistical analysis was carried out using SAS software version 9.2 (SAS, 2011). In order to calculate the basic statistical parameters, MEANS-SAS software version 9.2 (SAS, 2011) was applied. Significance of the influence of experimental factors (daily gains, average standardised back fat thickness, loin eye height, meatiness) was assessed based on the first two reproduction cycles. The following traits were taken into account: number of live-born piglets in a litter up to day 21 of life (heads), number of piglets reared from a litter (heads), number of piglets reared from a litter up to day 21 of life (heads). The assessment was made on 696 purebred PLW x PLW litters in total. The age of the first farrowing of the females and the inter-farrowing period (days) were also determined. Statistical analysis was carried out using SAS software version 9.2 (SAS, 2011). In order to calculate the basic statistical parameters, MEANS-SAS software version 9.2 (SAS, 2011) was applied. Significance of the influence of experimental factors (daily gains, average standardised back fat thickness, loin eye height, meatiness) was assessed using the multi-factor analysis of variance method with the application of GLM-SAS software version 9.2. (SAS, 2011) according to the following linear model:

\[ Y_{ijklmn} = \mu + g_i + b_j + k_l + m_k + t_m + e_{ijklmn} \]

where:
- \( Y_{ijklmn} \) is phenotypic value of the trait analysed;
- \( g_i \) is constant effect of i-th group of standardised daily gains (i=1,2,3,4);
- \( b_j \) is constant effect of j-th group of standardised back fat thickness (j=1,2,3);
- \( k_l \) is constant effect of l-th group of standardised loin eye height (l=1,2,3);
- \( m_k \) is constant effect of k-th group of standardised meatiness (k=1,2,3);
- \( t_m \) is constant effect of m-th year of observation (m=1,2);
- \( e_{ijklmn} \) is random error.

A range of multiple comparisons with the application of Duncan’s multiple range test was performed for detailed comparison of object means.

### Results and discussion

The overall statistical characteristics of the reproduction traits and the results of in vivo assessment of the examined population of Polish Large White sows are presented in Table 2. Average daily gains were higher than those reported for the national population of gilts of the PLW breed in the year 2010, which was on average 634 g (Eckert and Zak, 2011). In turn, the standardised loin eye height and average standardised meatiness of the examined females were slightly lower than those observed for the whole population of PLW sows (Eckert and Zak, 2011). In the year 2010, 19,330 sows of the PLW breed were subject to in vivo assessment of fattening and slaughter traits in Poland. The average standardised loin eye height for these females was 55.50 mm; average meatiness was 58.50%.

As demonstrated by Orzechowska and Mucha (2011), the average age of the first farrowing for PLW sows (average 349 days) was reported by Bocian et al. (2010). On the other hand, Jarczyk and Nogaj (2007) obtained different result; average first farrowing for PLW sows was 367 days. In the present study, the number of piglets

### Table 1. Basic composition of feed mixtures.

|                   | Gilts          | Pregnant sows | Lactating sows |
|-------------------|---------------|---------------|----------------|
| Dry matter, %     | 88            | 88            | 88             |
| Energy, MJ/kg     | 12.5          | 11.5          | 13             |
| Crude protein, %  | 15.5          | 12.5          | 17             |
| Digestible protein, % | 12.5   | 10            | 13             |
| Lysine, %         | 0.75          | 0.52          | 0.85           |
| Methionine, %     | 0.225         | 0.17          | 0.275          |

### Table 2. Overall statistical characteristics of the examined population of Polish Large White sows.

| Traits                    | Mean      | SD       | CV       |
|---------------------------|-----------|----------|----------|
| Weight on the day of assessment, kg | 104.42    | 10.78    | 10.32    |
| Standardised daily gain, g | 655.23    | 68.37    | 10.43    |
| Standardised back fat thickness at point P2, mm | 12.13    | 2.80    | 23.04    |
| Standardised back fat thickness at point P4, mm | 11.79    | 2.73    | 23.17    |
| Standardised back fat thickness from two measurements, mm | 11.96    | 2.68    | 22.41    |
| Standardised loin eye height, mm | 58.56    | 6.36    | 10.85    |
| Standardised meatiness, % | 58.08    | 2.98    | 5.14    |
| Age of the first farrowing, days | 359.15    | 36.87    | 10.27    |
| Inter-farrowing period, days | 168.68    | 31.53    | 18.70    |
| Number of live-born piglets in a litter, heads | 12.38    | 1.53    | 12.38    |
| Number of piglets reared from a litter up to day 21 of life, heads | 11.14    | 1.22    | 10.92    |

SD, standard deviation; CV, coefficient of variation.
born alive and reared was higher than those observed for the whole national population of PLW sows (Orzechowska and Mucha, 2011). Similar to the above-mentioned authors, Bocian et al. (2010), Jarczyk and Nogaj (2007) and Schwarz et al. (2009) reported lower numbers of live-born piglets for PLW sows. A higher litter size than that in the present study was observed by Wolf et al. (2008) for the Czech Large White (CLW) sows. The same author (Wolf, 2010), analysing the reproduction traits of CLW sows in the years 1995-2008, observed that in that period those sows bore on average 10.40 live piglets in the first farrowing and 11.30 in later ones. For Italian Large White, Pietrola et al. (2006) reported different results: 10.78 piglets born by primaparous sows.

Table 3 presents the results of the reproduction performance traits of Polish Large White sows taking into account the influence of growth rate (standardised daily gain) on reproduction performance of sows estimated on the basis of the first two reproduction cycles. The latest age for the first farrowing was reported for females from the group with the lowest daily gains (≤600 g); the age for the first farrowing in the group with the lowest daily gains (≥600 g) differed significantly from the other groups examined.

In the present study, the sows from the group with the lowest gains (≤600 g) were characterised by the lowest number of liveborn piglets in a litter. The most numerous litters were reported in females with the highest gains (>700 g). The results obtained by Kiernerová et al. (2006) for CLW sows suggest that higher body weight at the first service was related to higher daily gain. This demonstrated a beneficial effect on the maintenance of healthy sows and, therefore, better reproductive performance. Differences between the groups were statistically significant (P≤0.01). For the other groups with gains of 601-650 g and 651-700 g, the differences appeared to be statistically significant (P≤0.05). Similar results were obtained by Tummaruk et al. (2001) who concluded that the gilts with higher daily gains bore more piglets in a litter. Bocian et al. (2010) also reported a significantly positive correlation between daily gain and piglets born alive and reared from PLW sows.

Table 4 presents the statistical characteristics regarding the influence of the average standardised back fat thickness on reproduction results of the sows. Analysis of the results demonstrated that the females from the group with the highest back fat thickness (≥15 mm) bore the lowest number of piglets. The differences observed between the groups were highly statistically significant. It is likely that relatively high (over 15 mm) fatness in the PLW breed causes endocrine disturbance in young females. Information provided by the American Society for Reproductive Medicine seems to confirm this. Fat females show a characteristic transformation of estradiol to estriol, a weak estrogen. It is exactly this metabolism that may give rise to the worse reproduction results in excessively fatty sows. Tummaruk et al. (2001) reported different results. They observed that the sows characterised by higher back fat thickness had more numerous litters. Čechova and Tvrdoň (2006) did not demonstrate any significant influence of back fat thickness on the fertility of Czech Large White sows; however, they demonstrated some tendency (P<0.096) to increase the number of piglets born in a litter. Bocian et al. (2010) also observed no correlations between back fat thickness and the number of piglets born alive and reared from PLW sows. Gaughan et al. (1995) reported a low positive

### Table 3. Influence of growth rate (standardised daily gain) on reproduction performance traits.

| Standardised daily gains | ≤600 g n=72 | 601-650 g n=101 | 651-700 g n=94 | >700 g n=81 |
|-------------------------|-------------|----------------|---------------|------------|
| Age of the first farrowing, days | 373.59<sup>a</sup> 36.55 | 357.30<sup>b</sup> 34.85 | 356.81<sup>b</sup> 37.30 | 351.28<sup>a</sup> 35.91 |
| Inter-farrowing period, days | 173.61 37.12 | 169.42 30.07 | 165.57 30.58 | 160.79 28.90 |
| Number of live-born piglets in a litter, heads | 12.13<sup>a</sup> 1.59 | 12.24<sup>b</sup> 1.61 | 12.52<sup>b</sup> 1.40 | 12.61<sup>c</sup> 1.50 |
| Number of piglets reared from a litter up to day 21 of life, heads | 10.99 1.13 | 11.10 1.24 | 11.15 1.10 | 11.33 1.36 |

SD, standard deviation. Mean values marked in rows with different letters have statistically significant difference at P≤0.01. *<sup>a</sup>* Mean values marked in rows with different letters have statistically significant difference at P≤0.05.

### Table 4. Influence of standardised back fat thickness on reproduction performance features.

| ≤10 mm n=88 | Mean standardised back fat thickness | 11-15 mm n=227 | >15 mm n=33 |
|-------------|-------------------------------------|----------------|------------|
| Mean         | SD                                  | Mean           | SD         |
| Age of the first farrowing, days | 362.81 37.21 | 357.90 35.15 | 358.09 46.42 |
| Inter-farrowing period, days | 171.31 32.18 | 167.04 29.69 | 172.52 41.12 |
| Number of live-born piglets in a litter, heads | 12.36<sup>a</sup> 1.59 | 12.52<sup>b</sup> 1.40 | 11.47<sup>b</sup> 1.29 |
| Number of piglets reared from a litter up to day 21 of life, heads | 11.17 1.29 | 11.18 0.12 | 10.80 1.03 |

SD, standard deviation. Mean values marked in rows with different letters have statistically significant difference at P≤0.01.
phenotypic correlation between dorsal back fat thickness and fertility traits for Large White sows. Also Matysiak et al. (2010a) observed significantly positive correlations between back fat thickness and number of piglets born alive and reared in the first litter (until day 21 of life) in PLW sows.

Table 5 presents the results of reproduction performance traits of sows regarding the influence of standardised loin eye height. Statistical analysis demonstrated the significant influence (P≤0.01) of loin eye height on the number of live-born piglets in a litter in all the groups included in the study. Sows from the group characterised by the lowest loin eye height (≤55 mm) bore the least number of live piglets. The highest litter size at birth was observed in the group with the highest loin eye height (>60 mm). A similar tendency was observed by Rekiel and Wićcek (2002) who reported a higher number of piglets born alive and reared in sows characterised by higher loin eye height. It should be noted that these results, similar to the present study, concerned the first two reproduction cycles. Also Matysiak et al. (2010b) claimed that PLW sows characterised by the lowest loin eye height reared a significantly higher number of piglets in the first litter than females with higher loin eye height.

Finally, we analysed meatiness. Table 6 presents the statistical characteristics regarding the influence of the average standardised meatiness on reproduction results of the sows. Statistical analysis demonstrated the significant influence (P≤0.05) of meatiness on the age of the first farrowing and the number of live-born piglets in a litter (P≤0.01). The lowest age of the first farrowing was reported for sows from the group of meatiness in the range of 56-60%. The lowest number of live-born piglets was from females with less than 56% meatiness. Different results were obtained by Babicz et al. (2007). They observed that high meatiness of the sows (over 55%) contributes to lower reproduction indices, and especially to a smaller number of piglets born alive and reared up to day 21 of life. Also, Stasiak et al. (2004) reported that, despite the significant relationship between reproduction performance and muscle tone, the tendency for lowering the number of piglets born alive and reared from a litter up to day 21 of life can be observed with an increase in meatiness. Matysiak et al. (2010a) did not observe any significant influence of meatiness on the number of piglets born alive in a litter from Polish Large White sows. Furthermore, studies by Mijatović et al. (2009) and Bocian et al. (2010) did not demonstrate any influence of meatiness on the fertility of primiparous sows of the Swedish Landrace breed. Čechova et al. (2000) reported that increasing meatiness does not have a negative influence on the number of piglets born alive and reared from a litter.

Conclusions

On the basis of our results, it may be concluded that an improvement in fattening and slaughter traits did not have a negative influence on the reproduction traits in the first two production cycles of PLW sows. The sows from the group with the lowest gains were characterised by the lowest number of live-born piglets. The most numerous litters were reported in females with the highest gains. The highest number of live-born piglets was obtained from females with over 55% meatiness while the females with the highest back fat thickness bore the lowest number of piglets.

Table 5. Influence of standardised loin eye height on reproduction performance traits.

| Traits                          | ≤55 mm | 56-60 mm | >60 mm |
|---------------------------------|--------|----------|--------|
|                                | Mean   | SD       | Mean   | SD       | Mean   | SD       |
| Number of live-born piglets in a litter, heads | 11.53 | 1.32 | 12.60 | 1.49 | 12.80 | 1.47 |
| Number of piglets reared from a litter up to day 21 of life, heads | 10.97 | 0.96 | 11.14 | 1.29 | 11.26 | 1.30 |

Table 6. Influence of standardised meatiness on reproduction performance features.

| Traits                          | ≤55% | 56-60% | >60% |
|---------------------------------|------|--------|------|
|                                | Mean | SD     | Mean | SD     | Mean | SD     |
| Number of live-born piglets in a litter, heads | 11.87 | 1.04 | 11.94 | 1.40 | 12.07 | 1.50 |
| Number of piglets reared from a litter up to day 21 of life, heads | 11.00 | 1.00 | 11.14 | 1.29 | 11.26 | 1.30 |

SD, standard deviation. a,bMean values marked in rows with different letters have statistically significant difference at P≤0.01.

SD, standard deviation. a,bMean values marked in rows with different letters have statistically significant difference at P≤0.01. a,bMean values marked in rows with different letters have statistically significant difference at P≤0.05.
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