The use of performance test parameters for selection of gilts before their placement into breeding

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ABSTRACT: The objectives of the paper were to evaluate carcass value in reared gilts on the basis of carcass analysis during the station test of purebred progeny of pigs and ultrasonically with SONOMARK-100 or PIGLOG-105 instruments in the framework of valid methodology for performance testing, and to verify a possibility of prediction of backfat thickness and/or average daily weight gain since birth and lean meat content of gilts as the elements of objectification for the evaluation of their body condition. In total 54 gilts of two breeds were evaluated: the dam breed Czech Large White and the sire breed Czech Large White – sire line. Four-parameter Richards function was used for growth evaluation. The regression function $y = 63.870 - 0.447\ bt_1 - 0.510\ bt_2 + 0.128$ MLLT was applied in ultrasonic instruments for the calculation of lean meat content. We calculated linear regression functions for the conversion of performance testing parameters (gain from birth, average backfat thickness and lean meat content) from live weight on the day of measurement per live weight declared during selections in gilts.

Keywords: gilt; growth; carcass value; backfat thickness; lean meat content; body condition

In connection with increasing demands for the lean meat content in slaughter pigs and the knowledge of relations between reproductive and production traits, particularly carcass value, differentiated breeding of dam and sire breeds was introduced in the sixties and seventies of the last century.

Many authors, e.g. Engel and Walstra (1991), Demo (1994), Demo and Poltársky (1994), Pulkrábek et al. (1994), Walstra and Merkus (1995), Čechová and Mikule (2004), Vítek et al. (2004), etc. analysed the development of carcass value in pigs on the basis of carcass analyses or by *post mortem* instrumental methods.

Efforts to simplify the methods of performance testing, and particularly to cut their costs, led to the introduction of non-invasive ultrasonic instruments, among others into the system of performance testing for the estimation of breeding values of individuals before they are placed into the herd. Many foreign authors, e.g. Sather et al. (1987), Gresham et al. (1992), Demo et al. (1994), Kiray (1995) as well as Czech authors, e.g. Václavovský et al. (2002) evaluated the informative capacity of ultrasonic instruments used to measure the lean meat content.

The use of ultrasonic instruments worldwide and in this country resulted in changes in the system of performance testing in pigs and subsequently in modifications of the method of estimation of breeding values of animals. After pig progeny testing stations were abolished, a subindex for breeding value for lean meat content was substituted for the proportion of valuable lean cuts in the animal model for dam or sire breeds.

Recently, some researchers have pointed out the connection between the progress of selection for higher fleshiness and reproduction problems mainly in gilts. The placement of gilts into breeding is

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connected with early mating, and after conception with the lower number of piglets born in parity 1 and/or with a prolonged time until the onset of further practically utilisable oestrus that may be twice longer than in older sows. For these reasons producers may often be convinced that the gilt designed for replacement of the basic herd of sows is a risky factor. Besides nutrition, health and animal welfare the early mating of gilts, early weaning of piglets and optimum farrowing interval are the main production and economic efficiency factors in the piglet industry (Říha et al., 2001).

According to Schneeberger (2005) especially in young gilts in farrowing pens weight losses and negative changes in their body condition occur. He explains it by lower than required daily feed intake. He proves that in operating conditions nursing sows take in only 6 kg of feed on average instead of the required 7 kg. The lower intake of total mixed ration results in the loss of about 10 kg of live weight and 1.5 mm of backfat thickness during piglet sucking. Consequently, the sows have irregular or delayed oestrus, and the value of ovulation or implantation is also influenced negatively. These problems are typical of young gilts whose bodily growth has not been completed yet.

Recent knowledge of the relations between reproductive disorders and carcass composition of gilts (sows) indicates that the reduction of so called fat depot achieved by breeding may explain this problem only partially. However, the absolute or dynamic level of the lean meat content may be at the same time a critical parameter for the normal course of reproductive functions in gilts and sows (Říha et al., 2001).

Similar problems were solved in the papers of Kuhlers and Jungst (1993), Kerr and Cameron (1994), Klausing and Lenz (1994), Fiedler et al. (2001).

In the breeding process in pigs aimed at higher meat production not only carcass value and fattening performance traits but also growth and live weight development should be controlled. In original pig populations these characteristics are suitable prediction parameters of development and conformation traits of pigs.

The manifestations of growth are a resultant of interactions of all organ and functional systems of the animal. It is extremely difficult to define growth in a clear, exact and exhaustive way as many authors stated in their publications, e.g. Šiler et al. (1980), etc.

Some authors use performance traits for the evaluation of growth ability, others use parameters from testing stations (Pavlík et al., 1987; Pavlík and Kolář, 1989; etc.).

A number of methods has been developed to represent growth. Growth analyses were reviewed by Robison (1976). Fitzhugh (1976) and Kníže and Hyánek (1981) examined the growth of farm animals by means of growth curves. Knížetová (1994) studied relationships between the shape of growth curve, feed conversion and carcass quality. Growth curves can be analysed from husbandry and economic aspects.

The construction of growth models for farm animals in relation to various physiological functions was reported by many authors, e.g. Rogers et al. (1987), Emmans (1997), Hurwitz and Talpaz (1997).

MATERIAL AND METHODS

The objectives of the present paper were to determine the level of carcass value in reared gilts of the dam breed Czech Large White (CLW) and of the sire breed Czech Large White – sire line (CLWs) on the basis of "conventional" carcass analysis used by the end of 2003 at pig progeny stations for the testing of purebred progeny of pigs and ultrasonically with SONOMARK-100 (SM-100) or PIGLOG-105 (PI-105) instruments in the framework of valid methodology for performance testing, and to verify a possibility of prediction of backfat ("fat depot") thickness or average daily gain since birth and lean meat content in gilts as the elements of objectification in the evaluation of their body condition.

We used primary data from an experiment that was conducted to study growth and prediction of carcass value at a progeny testing station at Ústrašice in 2003–2004 in the framework of a station test of the reared purebred progeny of pigs (gilts in this case) of CLW (n = 20 gilts) and CLWs (n = 34 gilts) breeds according to modified methodology laid down by the Czech Standard (CSN 46 6164, 1990) and methodology for performance testing (PT). The methodology was modified by prolongation of the time of gilt rearing until the average live weight of 127 kg in order to obtain more exact parameters of PT (backfat thickness, depth of MLLT and lean meat content) in gilts of the weight approaching the values recommended before 1st mating.

Table 1. Parameters of Richards function in Czech Large White (CLW) and Czech Large White – sire line (CLWs) gilts

Breed	A (kg)	Parameters of Richards function			I_{yx}
		b	k	n	
CLW	174.2720	0.0906	0.0123	0.0189	0.9986
CLWs	165.6686	0.0428	0.0124	0.0092	0.9980

For the evaluation of growth abilities and construction of growth curves the gilts were weighed at periodic weekly intervals from birth (piglets in herds were weighed at the station until they reached ca. 25 kg) until they reached the average live weight of 127 kg. The growth curves, described by Richards (1959), were simulated according to Nýdl and Tichý (1989) whereas their parameters and characteristics were interpreted in accordance with Knížetová et al. (1985).

A day before slaughter the gilts were measured with ultrasonic instruments SM-100 and PI-105 according to the methodology for determination of PT parameters. A modification of the given methodology was that for the purposes of carcass analysis of the cold right side of pork the parameters of backfat thickness (bt_1 in mm), backfat thickness and depth of MLLT (bt_2 and MLLT in mm) were measured at a distance of 70 mm to the right laterally from the central line. The regression function y = 63.870 – 0.447 bt_1 – 0.510 bt_2 + 0.128 MLLT was used in both instruments for the expression of lean meat (LM) content.

In the next part of our study regression coefficients were calculated for the adjustment of parameters determined by PT (average gain from birth in g, average backfat thickness in mm, lean meat content in %) to single live weight. We used data on performance testing from central records of the Pig Breeders Union (PBU). Data on gilts were reclassified according to live weight as on the date of measurement in the interval of 4.9 kg in the weight range from 68 to 136 kg and adjusted for extremes. Correlation and regression analysis was done in a sampling set. Regression coefficients (b_{yx}) for the adjustment of values measured *in vivo* with the ultrasonic instrument SM-100 were obtained from the calculated linear regression equations. This part of the study was performed in the framework of the grant NAZV QC 1041 for PBU for all breeds and hybrid combinations of pigs used in the hybridisation programme in the Czech Republic.

RESULTS AND DISCUSSION

Tables 1 and 2 show the calculated parameters and characteristics for growth curves of gilts of the dam breed CLW and sire breed CLWs. Table 1 documents some differences in growth intensity between gilts of the two breeds: the values of coefficients k are almost identical but coefficients n are different. Coefficient k indicates changes in the logarithmic growth rate while coefficient n is considered by some authors, e.g. Knížetová (1994), as an “index of growth earliness”. In our experiment CLWs gilts were “earlier”. The evaluation of the growth of breeds showed that the fastest changes

Table 2. Characteristics of Richards function in Czech Large White (CLW) and Czech Large White – sire line (CLWs) gilts

Breed	Characteristics of Richards function						
	t_1 (days)	t_i (days)	t_2 (days)	y_i (kg)	v_i (g/day)	v (g/day)	I (%)
CLW	48.49	127.42	206.35	64.71	781	531	37.13
CLWs	46.03	123.98	201.92	61.23	752	511	36.96

y_i = live weight at the inflexion point (kg)
t_i = age at the inflexion point (days)
v_i = maximum gain at the inflexion point (g/day)
v = average daily gain since birth (g/day)
t_1 = age of maximum acceleration of growth (days)
t_2 = age of maximum deceleration of growth (days)
I = height of the inflexion point in % in relation to asymptotic weight

in growth in CLWs breed occurred in the auto-acceleration part of growth curve whereas changes in the growth rate in this part of growth curve in CLW breed were somewhat slower. CLWs breed appeared earlier in this phase.

Data in Table 2 illustrate changes in the shape of growth curves that occurred in the course of 10 years. E.g. Václavovský et al. (1993) reported coefficients I (%) expressing the ratio of weight at the inflexion point to asymptotic weight in CLW to be at the level of 46–47%. In the studied set this value was 37%. Thanks to the progress of breeding work and other changes in the production type the growth curves resemble by their shape growth curves of intensively growing farm animals, particularly poultry (Rogers et al., 1987) and the application of Gompertz three-parameter function would be possible. The curve has a shorter auto-acceleration part followed by a very long linear segment of growth. It is also evident from values t_1 when the growth acceleration is maximum (at 48–49 days of age in CLW), and from t_i and y_i, i.e. the definition of the inflexion point, which was reached in CLW at 64–65 kg and at 127–128 days, respectively. The growth curve of CLWs breed had a different shape. The auto-acceleration part is also short and steep, followed by a very slightly convexly curved long segment of growth. The linear phase is not expressed very much. The inflexion point was reached at a very early age before day 124 of age, around 61 kg, but the breed tends to "decelerate" its growth at about the 7th month of age.

Table 2 contains maximum and average daily gains. Evaluating their level (daily gain since birth 531 g and 511 g and maximum daily gain at the inflexion point 781 g and 752 g for CLW and CLWs, respectively) it is to note that the maximum manifestation of growth potential was not the objective of the growth experiment. The animals were selected for the growth experiment randomly, and the experiment should be viewed from the aspect of the rearing of breeding animals. The lower maxi-

Table 3. Basic statistics of primary traits in Czech Large White (CLW) and Czech Large White – sire line (CLWs) gilts

Parameter	Units	CLW			CLWs		
		n	$\bar{x} \pm s_{\bar{x}}$	s	n	$\bar{x} \pm s_{\bar{x}}$	s
Slaughter weight	kg	20	125.80 ± 0.46	2.07	34	124.09 ± 0.77	4.48
Right side of pork	kg	20	49.60 ± 0.36	1.59	34	48.94 ± 0.28	1.64
Carcass length	mm	20	830 ± 7.13	31.89	34	832 ± 3.05	17.76
Backfat thickness 1	mm	20	34.90 ± 0.20	6.97	34	29.72 ± 0.98	5.72
Backfat thickness 2	mm	20	21.50 ± 0.92	4.09	34	18.83 ± 0.68	3.96
Backfat thickness 3	mm	20	16.00 ± 1.17	5.25	34	12.39 ± 0.56	3.29
Average backfat thickness	mm	20	24.13 ± 1.12	4.99	34	20.31 ± 0.64	3.78
Loin	kg	20	6.04 ± 0.26	1.15	34	5.94 ± 0.10	0.57
Neck	kg	20	4.33 ± 0.17	0.75	34	4.37 ± 0.06	0.33
Shoulder	kg	20	5.03 ± 0.10	0.47	34	5.20 ± 0.04	0.25
Ham	kg	20	10.39 ± 0.18	0.80	34	10.70 ± 0.08	0.46
Belly	kg	20	8.47 ± 0.14	0.64	34	8.22 ± 0.12	0.70
Valuable lean cuts	%	20	52.02 ± 1.18	5.27	34	53.58 ± 0.43	2.50
Ham	%	20	20.95 ± 0.33	1.46	34	21.88 ± 0.18	1.06
Eye-muscle area	mm^2	20	6077 ± 90.30	851	34	6072 ± 55.72	908
SM – backfat thickness 1	mm	20	12.96 ± 1.00	4.48	34	9.96 ± 0.54	3.12
SM – backfat thickness 2	mm	20	15.08 ± 1.08	4.83	34	11.16 ± 0.72	4.20
SM – muscle depth	mm	20	59.96 ± 1.65	7.39	34	59.84 ± 1.23	7.20
SM – lean meat content	%	20	58.35 ± 0.83	3.72	34	61.64 ± 0.62	3.60
PI – backfat thickness 1	mm	20	15.60 ± 1.09	5.34	34	11.00 ± 0.50	2.89
PI – backfat thickness 2	mm	20	15.60 ± 0.89	3.98	34	11.79 ± 0.54	3.17
PI – muscle depth	mm	20	54.90 ± 2.40	10.71	34	55.58 ± 1.06	6.18
PI – lean meat content	%	20	55.89 ± 0.97	4.35	34	59.01 ± 1.03	5.99

mum and average gains in gilts of the sire breed are likely to be connected with higher demands for the formation and growth of muscle volume than in gilts of the dam breed.

Říha et al. (2001) reported a marked improvement of phenotype values in favour of daily gain in gilts of dam breeds CLW and CL with a positive decrease in the age at the 1st mating and farrowing, and of the number of all and live born piglets in parities 1 in the years 1995–1998. The reported weight gain of CLW gilts was 555 g. The value in Table 2 (531 g in CLW) proves the stabilised average growth ability and the values correspond with each other. Such growth intensity during rearing will make it possible to mate gilts within 7.5–8.5 months of age and in the weight range of 130–140 kg. So gilts will be mated in practically utilisable not in pubertal oestrus, and low conception rate and low number of piglets born per litter will be avoided. On the other hand, these values of weight gain during rearing ensure conditions for the harmony of growth with the development of body organs of a maturing individual and do not promote the fattening capacity of breeding animals prematurely.

Table 3 contains the basic statistics of primary traits of carcass value measured *post mortem* and *in vivo* in gilts of both breeds. These are animals in which the growth ability was examined during prolonged testing until the average live weight of 127 kg was reached.

The analysis of carcass data confirmed the trend of an increase in the absolute weight of main valuable cuts (MVC) in kg but it also showed that the proportion of MVC and ham decreased with increasing slaughter weight. The proportion of MVC and ham in slaughtered gilts of CLW and CLWs breeds was 52.02 ± 1.18% and 20.95 ± 0.33%, and 53.58 ± 0.43% and 21.88 ± 0.18%, respectively. The respective average backfat thickness in CLW and CLWs gilts was 24.13 ± 1.12 mm and 20.31 ± 0.64 at average slaughter weight of 125.80 ± 0.46 kg and 124.09 ± 0.77, respectively. For the Large White breed at 100 kg live weight Demo and Poltársky (1994) reported the proportion of MVC amounting to 49.23% and average backfat thickness of 24.3 mm; the proportion of MVC found out by Demo (1994) for hybrid combinations at the same weight was 51.26%, at 155 kg and higher it was 46.19% while the values reported by Pulkrábek et al. (1994) in gilts of CLW breed for the proportion of MVC (from detailed analyses at the average weight of sides of pork 46.63 ± 0.412 kg) were 49.31 ± 0.754%. Vítek et al. (2004), who studied the influence of slaughter weight on carcass value in various hybrid combinations produced in the CR, found out the lean meat content in dressed carcass at the weight of 125 kg and higher to amount to 54.32%.

To determine the lean meat content during growth with PI-105 and SM-100 instruments the animals were weighed a day before slaughter, i.e. at average live weight of 127 kg. Using the PI-105 instrument we measured the lean meat content of 55.89 ± 0.97% and 59.01 ± 1.03% in CLW and CLWs breed, respectively; the respective values measured with SM-100 were 58.35 ± 0.83% and 61.64 ± 0.62% while the values of backfat thickness bt_1 and bt_2 (for the same order of breeds) were 15.60 ± 1.09 mm and 15.60 ± 0.89 mm, and 11.00 ± 0.50 mm and 11.79 ± 0.54 mm if PI-105 was used. The SM-100 instrument showed the backfat thickness of 12.96 ± 1.00 mm and 15.08 ± 1.08 mm, and 9.96 ± 0.54 mm and 11.16 ± 0.72 mm, respectively. In hybrid combinations measured with PI-105 at the live weight above 115 kg Demo (1994) reported the value of lean meat content 49.37%, bt_1 25.68 mm and bt_2 26.10 mm. In breeding gilts of the White Meaty × Duroc combination and live weight above 120 kg these values were measured (with PI-105) by Demo et al. (1994): bt_1 = 23.68 mm, bt_2 = 22.39 mm and lean meat content 48.13%. Average lean meat content and average backfat thickness in gilts of CLW

Table 4. Regression coefficients for the adjustment of performance test parameters in CLW and CLWs gilts *in vivo* to single weight

Breed	Parameters		
	gilts (adjustment to 90 kg live weight)		gilts (adjustment to 100 kg live weight)
	average backfat thickness (mm)	average daily gain since birth (g)	average lean content (%)
CLW	0.0810	5.2429	–0.0423
CLWs	0.0490	5.5100	–0.0142

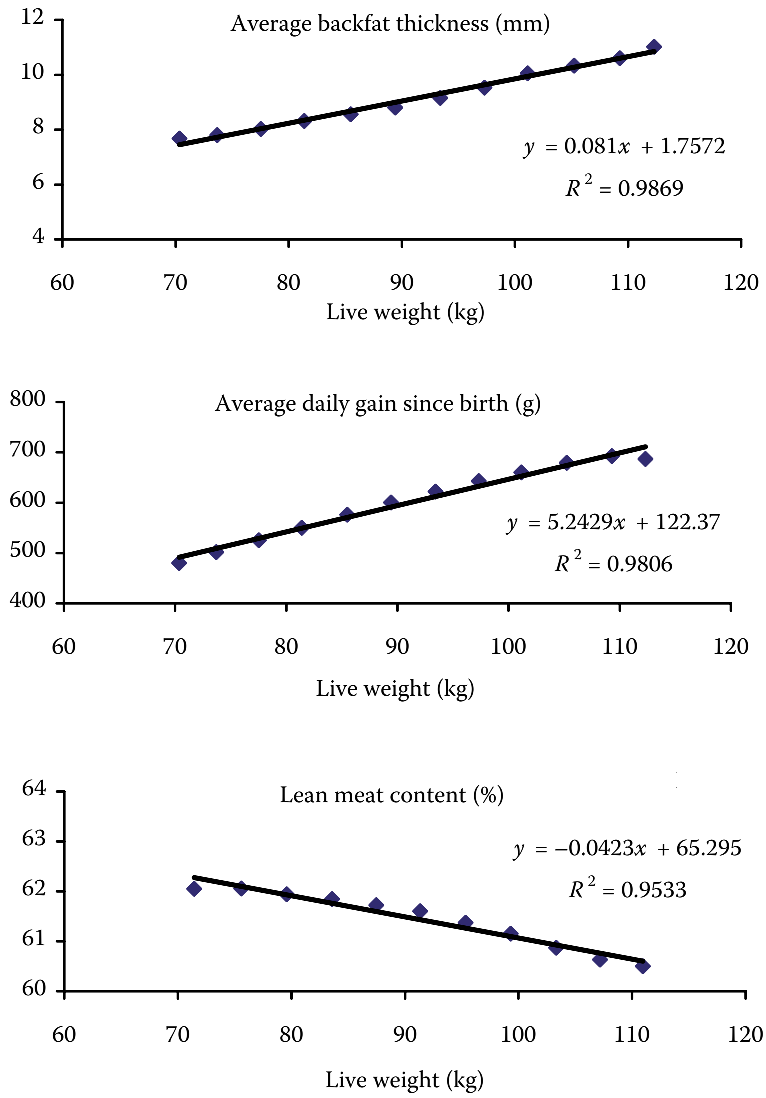

Figure 1. Regression function in gilts – Czech Large White

breed from performance testing in 1998 found out by Říha et al. (2001) were 58.59% and 10.66 mm, respectively. These authors also stated that the marked improvement of these phenotype values against 1995 did not have a negative influence on the reproductive performance of gilts; on the contrary, a positive decrease in age at the 1st mating and/or farrowing was demonstrated as well as a positive trend of the number piglets born in parity 1.

Table 4 shows regression coefficients for breeding gilts of CLW and CLWs breeds currently used by the PBU for the adjustment of parameters under PT to single live weight. Average daily gain and average backfat thickness are converted (in accordance with the valid methodology – CSN 46 6164 standard) per 90 kg live weight whereas lean meat content is converted per 100 kg live weight. Figures 1 and 2 show the trends of measured traits during rearing at the weight intervals 70–110 kg when they are determined. The regression equations, characterised by the linear course of correlations with a high level of closeness of the examined relations given by the value of determination coefficient in the range of 0.57 to 0.98 (r_{xy} = 0.76–0.99), document general regularities of increasing backfat thickness and decreasing lean meat content in the body of gilts with increasing live weight.

As some findings from the evaluation of suitability of methodical procedures in breeding programmes of dam breeds after the correlation analysis of the relations between basic performance parameters and breeding measures applied in breeding herds was done, lead to partial conclusions that the level of reproductive traits in the herd is not fully associated with the level of traits from station tests and because the coefficients of correlation between data describing selection intensity

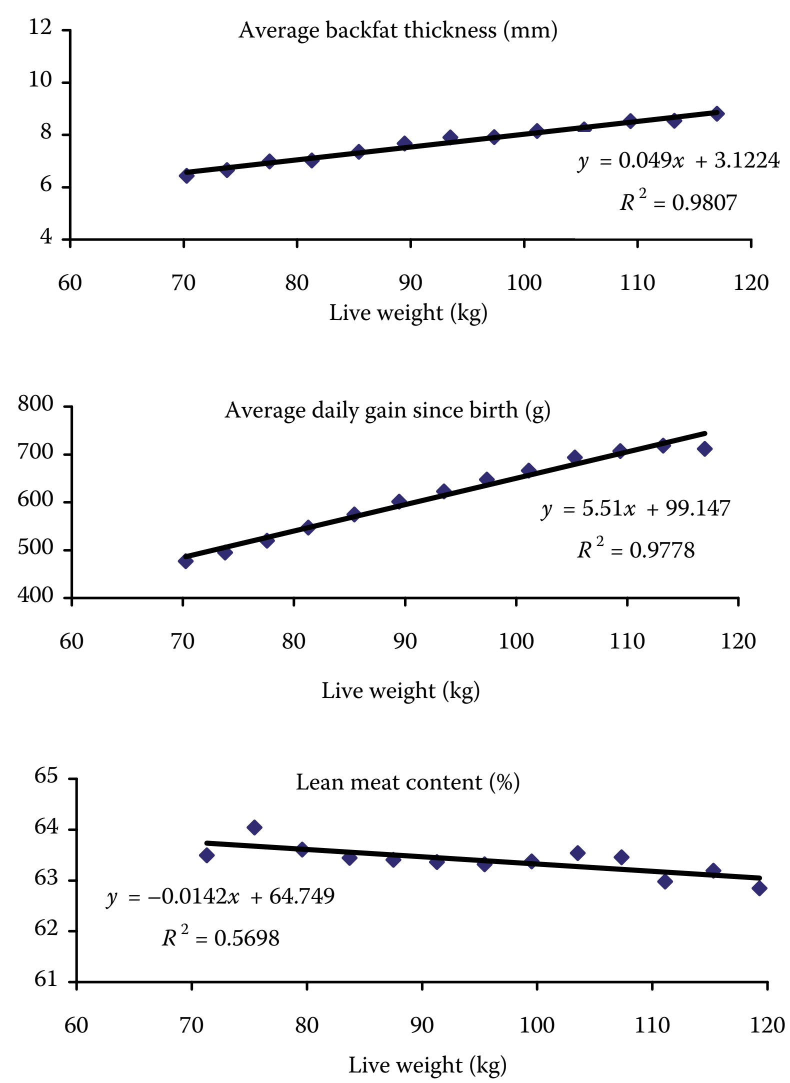

Figure 2. Regression function in gilts – Czech Large White-sire line

during the rearing of breeding animals and reproductive traits and/or traits from a field test have low statistically insignificant values (Fiedler et al., 2001), it would be suitable to introduce some objective elements into mostly subjective evaluation of the body condition of gilts (sows). Besides weight gain these elements may be average backfat thickness from measurements bt_1 and bt_2 and lean meat content as determined by PT in gilts and converted according to the above-mentioned regression functions from the weight at the day of measurement per weight declared at selections. The graders (the commission) evaluating the type, constitution and conformation of breeding gilts will be given an objective guide for the allocation of scores 1–5 for the type (lean meat content) and for the condition (backfat thickness).

Klausing and Lenz (1994) proposed the evaluation of sow body condition by a four-point scale (1 – good, 2 – slightly thin, 3 – very thin, 4 – fat). The aim of husbandry and feeding techniques and nutrition should be to maintain sows in condition 1–2 for the whole reproduction cycle while condition 3 is acceptable only at the end of lactation. They point to the relationship between backfat thickness and parity. Gilts (parities 1) with backfat thickness of 23 mm have a good condition, those with 17–23 mm have a "normal" condition and animals with less than 17 mm of fat have a bad condition. It is recommended to mate gilts at live weight of 125–145 kg and backfat thickness between 18 and 20 mm.

German producers consider objective ultrasonic measurements as a good method of checking the subjective evaluation of condition. Measurements are done at the last thoracic vertebra at a distance of 65 mm from the central line (Schweinezucht und Schweinemast, 1998). This method corresponds with the measurement of backfat thickness bt_2 when PT parameters are determined in the Czech Republic.

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