



Науковий вісник Львівського національного університету
ветеринарної медицини та біотехнологій імені С.З. Гжицького.
Серія: Сільськогосподарські науки

Scientific Messenger of Lviv National University
of Veterinary Medicine and Biotechnologies.
Series: Agricultural sciences

ISSN 2519–2698 print
ISSN 2707-5834 online

doi: 10.32718/nvlvet-a10117
<https://nvlvet.com.ua/index.php/agriculture>

UDC 636.4.082.12

Breeding value of sows: selection criteria of highly productive animals and economic assessment of their use

V. Khalak¹✉, B. Gutyj², O. Bordun³, O. Khmelova⁴, O. Stadnytska⁵, N. Kibenko⁶, N. Kravchenko⁶,
O. Shcherbak⁶, M. Ilchenko⁷

¹State institution – Institute of Grain Crops, National Academy of Sciences of Ukraine, Dnipro, Ukraine

²Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv, Ukraine

³Institute of Agriculture of the North-East of NAAS of Ukraine, v. Sad, Sumy region, Ukraine

⁴Dnipro State Agrarian and Economic University, Dnipro, Ukraine

⁵Institute of Agriculture of the Carpathian Region of NAAS of Ukraine, Obroshino, Ukraine

⁶State Biotechnology University, Kharkiv, Ukraine

⁷Poltava State Agrarian University, Poltava, Ukraine

Article info

Received 18.07.2024

Received in revised form

22.08.2024

Accepted 23.08.2024

Khalak, V., Gutyj, B., Bordun, O., Khmelova, O., Stadnytska, O., Kibenko, N., Kravchenko, N., Shcherbak, O., & Ilchenko, M. (2024). Breeding value of sows: selection criteria of highly productive animals and economic assessment of their use. Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies. Series: Agricultural sciences, 26(101), 101–108. doi: 10.32718/nvlvet-a10117

State Institution Institute of
grain crops of NAAS, V. Vernadsky
Str., 14, Dnipro, 49027, Ukraine.
Tel.: +38-067-892-44-04
E-mail: v16kh91@gmail.com

Stepan Gzhytskyi National
University of Veterinary Medicine
and Biotechnologies Lviv,
Pekarska Str., 50, Lviv,
79010, Ukraine.

Institute of Agriculture of the
North-East of NAAS of Ukraine,
Zelena Str., 1, v. Sad, Sumy region,
42343, Ukraine.

Dnipro State Agrarian and
Economic University,
S. Efremov Str., 25, Dnipro,
49600, Ukraine.

Institute of Agriculture of the
Carpathian region of the National
Academy of Agrarian Sciences of
Ukraine, Grushevs'kogo Str. 5,
Obroshino, Pustomytskyi District,
Lviv Region, 81115, Ukraine.

State Biotechnological University,
Alchevsky Str., 44, Kharkiv,
61002, Ukraine.

Poltava State Agrarian University,
Skovorody Str., 1/3, Poltava,
36006, Ukraine.

The purpose of the work was to investigate the indicators of own productivity of repair pigs and the reproductive qualities of sows of different intrabreed differentiation according to the BLUP index and the selection index of reproductive qualities of the sow (SIRQS) to determine the criteria for the selection of highly productive animals according to these indicators and to calculate the economic efficiency of their use in the conditions of controlled populations. The breeding value of the animals of the specified production group was determined by the BLUP index (maternal line) and the selection index of reproductive qualities of the sow (SIRQS). It was established that repair pigs of the large white breed of the controlled population belong to the elite class according to their productivity (age of reaching a live weight of 100 kg, days; fatback thickness at the level of 6–7 thoracic vertebrae, mm). The leading indicators of multifertility ($12.5 \pm 0.24 - 13.1 \pm 0.16$ heads), the number of piglets at the time of weaning ($10.5 \pm 0.17 - 10.8 \pm 0.14$ heads), and the weight of the nest at the time weaning at the age of 28 days ($82.2 \pm 1.38 - 84.2 \pm 1.03$ kg) is characterized by sows of the first experimental group of intrabreed differentiation according to the BLUP index (maternal line) and according to the selection index of reproductive qualities of the sow (SIRQS). The leading indicator of high fertility ($1.35 \pm 0.021 - 1.38 \pm 0.018$ kg) and the minimum value of the index of evenness (homogeneity) of the sow's nest by live weight of piglets at the time of their birth (IVH₀) ($4.11 \pm 0.202 - 3.52 \pm 0.128$ score) was found in sows of the III sub-experimental group. The coefficient of variation (Cv, %) of the reproductive qualities of sows of the large white breed of different breeding values, evaluated according to the BLUP index (maternal line) and the selection index of the reproductive qualities of the sow (SIRQS) ranges from 5.08 ± 0.625 to 25.83 ± 2.965 %. The coefficient of pairwise correlation (r) between the characteristics of the own productivity of repair pigs, reproductive qualities of sows, the BLUP index (maternal line), and the selection index of reproductive rates of the sow (SIRQS) ranges from -0.714 ($tr = 19.04$) to $+0.985$ ($tr = 446.98$). The use of sows of high breeding value, evaluated according to the BLUP index (maternal line) and the selection index of reproductive qualities of the sow (SIRQS) (I sub-experimental group), provides additional production at the level of $+6.69 - +8.08$ % and its value are $+240.14 - +319.47$ UAH or $+6.07 - +8.08$ US dollars. The criterion for selecting highly productive animals of controlled populations according to the BLUP index (maternal line) is an indicator of $111.53-165.23$ points, and the selection index of reproductive qualities of the sow (SIRQS) is $95.03-115.08$ points.

Key words: sow, breed, own productivity, reproductive qualities, BLUP index, selection index of sow reproductive qualities (SIRQS), breeding value, variability, correlation, economic efficiency.

Племінна цінність свиноматок: критерії відбору високопродуктивних тварин та економічна оцінка їх використання

В. І. Халак¹, Б. В. Гутій², О. М. Бордун³, О. В. Хмельова⁴, О. І. Стадницька⁵, Н. Ю. Кібенко⁶, Н. О. Кравченко⁶, О. В. Щербак⁶, М. О. Ільченко⁷

¹Державна установа Інститут зернових культур НААН, м. Дніпро, Україна

²Львівський національний університет ветеринарної медицини та біотехнологій імені С. З. Гжицького, м. Львів, Україна

³Інститут сільського господарства Північного Сходу НААН, с. Сад, Сумський р-н, Сумська обл., Україна

⁴Дніпровський державний аграрно-економічний університет, м. Дніпро, Україна

⁵Інститут сільського господарства Карпатського регіону НААН України, с. Оброшине, Львівська область, Україна

⁶Державний біотехнологічний університет, м. Харків, Україна

⁷Полтавський державний аграрний університет, м. Полтава, Україна

Метою роботи передбачалося дослідити показники власної продуктивності ремонтних свинок та відтворювальних якостей свиноматок різної внутріпородної диференціації за індексом BLUP та селекційним індексом відтворювальних якостей свиноматки (СІВЯС), визначити критерії відбору високопродуктивних тварин за даними показниками та розрахувати економічну ефективність їх використання в умовах підконтрольних популяцій. Племінну цінність тварин зазначеної виробничої групи визначали за індексом BLUP (материнська лінія) та селекційним індексом відтворювальних якостей свиноматки (СІВЯС). Оцінку молодняку свиней за показниками власної продуктивності, свиноматок – за відтворювальними якостями проводили з урахуванням наступних ознак: вік досягнення живої маси 100 кг, днів; товщина шпигу на рівні 6–7 грудного хребця, мм; товщина шпигу в середній точці спини між холкою і крижками, мм; товщина шпигу на крижах, мм; довжина тулубу, см; багатоплідність, гол; молочність, кг, кількість поросят на час відлучення, гол; маса гнізда на час відлучення у віці 28 діб, кг, збереженість, %. Комплексну оцінку свиноматок проводили за методикою В. І. Халака (2012). Біометричну обробку результатів дослідження та розрахунок вартості додаткової продукції проводили за загальноприйнятими методиками. Установлено, що ремонтні свинки великої білої породи підконтрольної популяції за ознаками власної продуктивності (вік досягнення живої маси 100 кг, діб; товщини шпигу на рівні 6–7 грудних хребців, мм) належать до класу еліта. Максимальними показниками багатоплідності ($12,5 \pm 0,24 - 13,1 \pm 0,16$ гол), кількості поросят на час відлучення ($10,5 \pm 0,17 - 10,8 \pm 0,14$ гол) та маси гнізда на час відлучення у віці 28 діб ($82,2 \pm 1,38 - 84,2 \pm 1,03$ кг) характеризуються свиноматки I піддослідної групи внутріпородної диференціації за індексом BLUP (материнська лінія) та за селекційним індексом відтворювальних якостей свиноматки. Максимальний показник великоплідності ($1,35 \pm 0,021 - 1,38 \pm 0,018$ кг) та мінімальне значення індексу вирівняності (однорідності) гнізда свиноматки за живою масою поросят на час їх народження (ІВГ₀) ($4,11 \pm 0,202 - 3,52 \pm 0,128$ бала) виявлено у свиноматок III піддослідної групи. Коефіцієнт варіації (C_v, %) відтворювальних якостей свиноматок великої білої породи різної племінної цінності, оцінених за індексом BLUP (материнська лінія) та селекційним індексом відтворювальних якостей свиноматки (СІВЯС) коливається у межах від $-0,714$ ($t_r = 19,04$) до $+0,985$ ($t_r = 446,98$). Використання свиноматок високої племінної цінності, оцінених за індексом BLUP (материнська лінія) та селекційним індексом відтворювальних якостей свиноматки (СІВЯС) (I піддослідна група) забезпечує одержання додаткової продукції на рівні $+6,69 - +8,08$ %, а її вартість становить $+240,14 - +319,47$ гривень або $+6,07 - +8,08$ доларів США. Критерієм відбору високопродуктивних тварин підконтрольних популяцій за індексом BLUP (материнська лінія) є показник на рівні $111,53 - 165,23$ балів, селекційним індексом відтворювальних якостей свиноматки (СІВЯС) – $95,03 - 115,08$ балів.

Ключові слова: свиноматка, порода, власна продуктивність, відтворювальні якості, індекс BLUP, селекційним індексом відтворювальних якостей свиноматки, племінна цінність, мінливість, кореляція, економічна ефективність.

Introduction

It has been established that the effectiveness of selection and breeding work in pig breeding is significantly influenced by using one method of assessing breeding value (Getya et al., 2010; Akimov, 2010; Hryshyna and Fesenko, 2015; Kramarenko et al., 2019; Tsereniuk et al., 2021; Khalak et al., 2021; 2022; Kremez et al., 2022). Thus, the breeding value of repaired young animals, sows, and breeding boars, following the requirements of the Pig grading instructions (Instructions on the sounding of pigs, 2003), is determined by live weight and body length (Appendix 1–4), the age of reaching a live weight of 100 kg (Appendix 5), fatback thickness (Appendix 6), by indicators of reproductive qualities (appendix 7, 8), quality of sperm production (appendix 9), as well as by fattening and meat qualities of offspring (appendix 11). Individual records of the phenotypic manifestation of quantitative

traits in animals of different sex-age groups are kept in breeding farms. A complex class is determined based on objective data (Appendix 12). However, the date of the specified regulatory document is not always accurate.

According to many domestic and foreign scientists, a more objective breeding value assessment can be obtained based on evaluation and selection indices, the BLUP method, and genetic markers (Koivula et al., 2012; Nebylytsia, 2013; Ahapova & Susol, 2015; Vashchenko et al., 2015; Martyniuk et al., 2019; Khalak & Gutyj, 2020; Simonov et al., 2022; Sameliuk et al., 2022; Povod et al., 2022).

The aim of the study

Aim of the work – to investigate indicators of own productivity of repair pigs and reproductive qualities of sows of different intrabreed differentiation according to the BLUP index and the selection index of reproductive

qualities of sows (SIRQS), to determine the criteria for the selection of highly productive animals according to these indicators and to calculate the economic efficiency of their use in the conditions of controlled populations.

Materials and methods

The research was carried out in the agricultural formations of the Dnipropetrovsk region (AF “Borysfen”, Ukraine) as well as the animal husbandry laboratory of the State Institution “Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine”.

The object of the study was to repair pigs and sows of the large white breed. The BLUP index (Best Linear Unbiased Prediction) was calculated based on the leading institution (Institute of Pig Breeding and APM of the National Academy of Sciences) according to the general model of a single animal, which has the following form:

$$y_i = x_i'b + a_i + e_i \quad (1)$$

Where: y_i – observation of the characters in the i th animal; $x_i'b$ – the sum of fixed effects related to the i th animal; a_i – random additive genetic effect of the i th animal; e_i is a random deviation (residual) (Vashchenko, 2010).

Evaluation of young pigs according to their productivity indicators, sows – according to reproductive qualities, was carried out taking into account the following characteristics: age of reaching a live weight of 100 kg, days; fatback thickness at the level of the 6th–7th thoracic vertebra, mm; the thickness of the fatback in the middle point of the back between the withers and the sacrum, mm; thickness of fatback on the sacrum, mm; body length, cm; multifertility, head; milk yield, kg, number of piglets at the time of weaning, heads; nest weight at the time of weaning at the age of 28 days, kg, survival of piglets before weaning, %.

An ultrasonic device renko lean meater digital back-fatback idic, S/N 46080 (USA), was used to measure the thickness of the peak.

The selection index of reproductive qualities of the sow (2) and the index of evenness (homogeneity) of the sow's nest according to the live weight of the piglets at the time of their birth (3) were calculated according to the following formulas:

$$SIRQS = (6 \times X_1) + \left[9.34 \times \left(\frac{X_2}{X_3} \right) \right] \quad (2)$$

where: SIRQS – selection index of reproductive qualities of the sow, score; X_1 – multifertility, hd.; X_2 – weight of the nest of piglets at weaning, kg; X_3 – age at weaning, days (Tsereniuk et al., 2010);

$$IVH_0 = \frac{n}{2.5 - \left(\frac{x_{max} - x_{min}}{X} \right)} \quad (3)$$

where: IVH_0 is the index of evenness (homogeneity) of the sow's nest by the live weight of piglets at the time of their birth, score; n – multifertility, head; 2.5 – the maximum indicator of live weight of one piglet at the time of birth, kg; x_{max} – the live weight of the piglet with the leading indicator in the nest at the time of delivery, kg; x_{min} – the live weight of the piglet with the minimum indicator in the nest at the time of delivery, kg; X is the average live weight of piglets in the nest at the time of delivery (sow fertility), kg (Khalak, 2015);

The feeding and keeping conditions of the sows of the experimental groups were identical and corresponded to zootechnical standards.

The calculation of the value of additional products and biometric indicators (Kovalenko et al., 2010) was carried out according to generally accepted methods using the programmable module “Data Analysis” in Microsoft Excel.

The strength of correlations between features was determined by the Chaddock scale (Sidorova et al., 2003) (Table 1).

Table 1
Chaddock's scale for grading the strength of correlation

The value of the correlation coefficient	Correlation strength
0.1–0.3	Weak
0.3–0.5	Moderate
0.5–0.7	Moderate
0.7–0.9	High
0.9–0.99	Very high

Results and discussion

It was established that the age of reaching a live weight of 100 kg of repair pigs ($N = 171$) is 192.7 ± 0.85 days, the thickness of fatback at the level of 6–7 thoracic vertebra is 22.5 ± 0.28 mm, the thickness of fatback at the middle point the back between the withers and the sacrum is 17.7 ± 0.23 mm, the thickness of the fatback on the sacrum is 18.5 ± 0.26 mm, the length of the trunk is 116.4 ± 0.26 cm. The fertility of sows ($N = 171$) is 10.6 ± 0.09 head, and the weight of the nest at the time of weaning at the age of 28 days – is 76.7 ± 0.74 kg. The BLUP index (maternal line) in sows of the controlled population is equal to 97.68 ± 1.531 points, and the selection index of reproductive qualities of the sow (SIRQS) is 85.31 ± 1.107 points. The indicator “preservation of piglets until weaning at 28 days” ranges from 71.4 to 100 %.

The coefficient of variability of the signs of own productivity of repair pigs and reproductive qualities of sows ranges from 2.98 to 19.80 % (Table 2).

The analysis of data on the reproductive qualities of sows taking into account their intrabreed differentiation according to the BLUP index (maternal line), shows that the difference between the animals of the I and III sub-experimental groups in terms of multifertility is 4.1 piglets per farrowing ($td = 9.76$, $P < 0.001$), the number of piglets at the time of weaning – 2.4 heads ($td = 9.23$, $P < 0.001$), the weight of the nest at the time of weaning at the age of 28 days – 12.0 kg ($td = 5.40$, $P < 0.001$), the selection index reproductive qualities of the sow (SIRQS) – 28.04 points ($td = 9.73$, $P < 0.001$) (Table 3).

In terms of high fertility, the difference between sows in favor of animals of the III group is 0.17 kg ($td = 7.39$, $P < 0.001$), the index of evenness (homogeneity) of the sow's nest according to the live weight of piglets at the time of their birth (IVH_0) is 2.21 score ($td = 9.20$; $P < 0.001$). This shows that sows with the minimum number of piglets at the time of their birth and the leading indicators of live weight are characterized by greater nest homogeneity in terms of the live weight of piglets at the time of their birth. The maximum rate of survival of pig-

lets to weaning at the age of 28 days (96.4 ± 1.13 %) was also found in sows of the III sub-experimental group.

Taking into account the intrabreed differentiation of animals according to the selection index of reproductive qualities of the sow (SIRQS), it was established that the difference between the animals of the I and III sub-experimental groups

in terms of multifertility is equal to 5.6 piglets per farrowing ($td = 18.42, P < 0.001$), the number of piglets per weaning time – 3.8 heads ($td = 18.09, P < 0.001$), nest weight at the time of weaning at the age of 28 days – 18.8 kg ($td = 10.74, P < 0.001$), BLUP index (maternal line) – 36.52 points ($td = 9.38, P < 0.001$) (Table 4).

Table 2

Indicators of the variability of indicators of the level of adaptation and reproductive qualities of sows of the large white breed, N = 171

Indicators, units of measurement	Biometric indicators	
	$\sigma \pm S\sigma$	$Cv \pm Scv, \%$
Age of reaching 100 kg live weight, days	11.24 ± 0.607	5.83 ± 0.315
The thickness of the fatback at the level of the 6th-7th thoracic vertebra, mm	3.70 ± 0.200	16.45 ± 0.906
The thickness of the fatback in the middle point of the back between the withers and the sacrum, mm	3.02 ± 0.163	17.08 ± 0.923
The thickness of the fatback on the sacrum, mm	3.42 ± 0.184	18.41 ± 0.995
Body length, cm	3.46 ± 0.187	2.98 ± 0.161
Multifertility, ch	2.10 ± 0.113	19.80 ± 1.070
Fertility, kg	0.10 ± 0.005	8.73 ± 0.472
Number of piglets at the time of weaning, head	1.22 ± 0.065	12.70 ± 0.686
Nest weight at the time of weaning at the age of 28 days, kg	9.70 ± 0.524	12.67 ± 0.685

Table 3

Reproductive qualities of sows of the large white breed of different breeding values, evaluated by the BLUP index (maternal line)

Indicators, units of measurement	Biometric indicators	Gradations of the BLUP index (maternal line)		
		111.53–165.23	88.00–110.62	53.42–84.08
		group		
		I	II	III
	n	33	100	38
Multifertility, heads	$X \pm Sx$	12.5 ± 0.24	10.8 ± 0.14	8.4 ± 0.35
	$\sigma \pm S\sigma$	1.39 ± 0.171	1.47 ± 0.103	2.17 ± 0.249
	$Cv \pm Scv, \%$	11.12 ± 1.369	13.61 ± 0.962	25.83 ± 2.965
The number of sows of the “elite” class	heads	31	56	7
	%	93,93	56,0	18,42
Fertility kg,	$X \pm Sx$	1.18 ± 0.011	1.23 ± 0.008	1.35 ± 0.021
	$\sigma \pm S\sigma$	0.06 ± 0.007	0.08 ± 0.005	0.13 ± 0.014
	$Cv \pm Scv, \%$	5.08 ± 0.625	6.50 ± 0.459	9.62 ± 1.104
IVH ₀ , point	$X \pm Sx$	6.32 ± 0.143	5.46 ± 0.099	4.11 ± 0.202
	$\sigma \pm S\sigma$	0.82 ± 0.100	0.99 ± 0.070	1.24 ± 0.141
	$Cv \pm Scv, \%$	12.97 ± 1.597	18.13 ± 1.282	30.17 ± 3.463
Number of piglets at the time of weaning, heads	$X \pm Sx$	10.5 ± 0.17	9.7 ± 0.10	8.1 ± 0.20
	$\sigma \pm S\sigma$	1.03 ± 0.126	1.05 ± 0.074	1.24 ± 0.142
	$Cv \pm Scv, \%$	9.80 ± 1.206	10.82 ± 0.765	14.09 ± 1.617
Weight of the nest at the time of weaning, at the age of 28 days, kg	$X \pm Sx$	82.2 ± 1.38	77.2 ± 0.84	70.2 ± 1.75
	$\sigma \pm S\sigma$	7.93 ± 0.976	8.43 ± 0.596	10.78 ± 1.237
	$Cv \pm Scv, \%$	9.64 ± 1.187	10.91 ± 0.771	15.35 ± 1.762
Preservation of piglets until weaning, %.	$X \pm Sx$	84.0 ± 1.55	89.8 ± 0.89	96.4 ± 1.13
	lim	81.48–115.08	59.47–113.05	40.54–94.05
A selection index of reproductive qualities of the sow (SIRQS) score	$X \pm Sx$	98.10 ± 1.596	86.88 ± 1.024	70.06 ± 2.40
	$\sigma \pm S\sigma$	9.17 ± 1.129	10.24 ± 0.724	14.79 ± 1.698
	$Cv \pm Scv, \%$	9.34 ± 1.150	11.78 ± 0.833	21.11 ± 2.423

The maximum indicator of high fertility (1.38 ± 0.018 kg) and the minimum value of the index of sow nest alignment (homogeneity) according to the live weight of piglets at the time of their birth (IVH₀) (3.52 ± 0.128 points) were found in sows of the III sub-experimental group.

The coefficient of variation (Cv, %) of the reproductive qualities of sows of the large white breed of different breeding value, assessed by the BLUP index (maternal line) and the selection index of the reproductive qualities

of the sow (SIRQS) ranges from 5.08 ± 0.625 to 25.83 ± 2.965 %.

The results of the calculation of the pairwise correlation coefficients between the characteristics of the own productivity of repair pigs, the reproductive qualities of sows, the BLUP index (maternal line), and the selection index of the reproductive qualities of the sow (SIRQS) are shown in Table 5.

Table 4

Reproductive qualities of sows of the large white breed of different breeding values, evaluated by the selection index of reproductive qualities of the sow (SIRQS), score

Indicators, units of measurement	Biometric indicators	Gradations of the selection index of reproductive qualities of the sow (SIRQS), score		
		95.03–115.08	76.27–94.94	40.54–75.61
		Group		
		I	II	III
	n	38	99	34
Multifertility, heads	$X \pm Sx$	13.1 ± 0.16	10.7 ± 0.08	7.5 ± 0.26
	$\sigma \pm S\sigma$	0.99 ± 0.113	0.88 ± 0.062	1.52 ± 0.184
	$Cv \pm Scv, \%$	7.55 ± 0.866	8.22 ± 0.584	20.26 ± 2.458
The number of sows of the “elite” class	heads	38	56	0
	%	100,0	56,56	0
Fertility, kg	$X \pm Sx$	1.17 ± 0.010	1.22 ± 0.078	1.38 ± 0.018
	$\sigma \pm S\sigma$	0.07 ± 0.008	0.07 ± 0.004	0.10 ± 0.012
	$Cv \pm Scv, \%$	5.98 ± 0.686	5.73 ± 0.407	7.24 ± 0.878
IVH ₀ , point	$X \pm Sx$	6.70 ± 0.135	5.42 ± 0.063	3.52 ± 0.128
	$\sigma \pm S\sigma$	0.83 ± 0.095	0.63 ± 0.044	0.75 ± 0.091
	$Cv \pm Scv, \%$	12.38 ± 1.421	11.62 ± 0.825	21.30 ± 2.584
Number of piglets at the time of weaning, head	$X \pm Sx$	10.8 ± 0.14	9.7 ± 0.08	7.0 ± 0.17
	$\sigma \pm S\sigma$	0.86 ± 0.098	0.86 ± 0.061	1.02 ± 0.123
	$Cv \pm Scv, \%$	7.96 ± 0.913	8.86 ± 0.629	14.57 ± 1.768
Weight of the nest at the time of weaning, at the age of 28 days, kg	$X \pm Sx$	84.2 ± 1.03	77.6 ± 0.76	65.4 ± 1.42
	$\sigma \pm S\sigma$	6.37 ± 0.731	7.61 ± 0.540	8.28 ± 1.004
	$Cv \pm Scv, \%$	7.56 ± 0.867	9.80 ± 0.696	12.66 ± 1.536
Preservation of piglets until weaning, %	$X \pm Sx$	82.4 ± 1.18	90.6 ± 0.86	93,3 ± 1,00
	lim	90.47–165.23	56.61–146.90	53.42–106.78
BLUP index (maternal line), score	$X \pm Sx$	115.17 ± 2.914	97.51 ± 1.600	78,65 ± 2,579
	$\sigma \pm S\sigma$	17.96 ± 2.061	15.92 ± 1.131	15,04 ± 1,825
	$Cv \pm Scv, \%$	15.59 ± 1.789	16.32 ± 1.159	19,12 ± 2,320

Table 5

Coefficient of pairwise correlation between features of own performance of repair pigs, reproductive qualities of sows, BLUP index (maternal line), and selection index of reproductive qualities of sows (SIRQS)

Feature		Biometric indicators		Correlation strength
x	y	r ± Sr	tr	
<i>BLUP index (maternal line), score</i>	1	-0.113 ± 0.0755	1.49	Weak
	2	0.040 ± 0.0764	0.53	-
	3	-0.379 ± 0.0655***	5.79	Moderate
	4	-0.228 ± 0.0725**	3.14	Weak
	5	-0.296 ± 0.0698***	4.24	Weak
	6	0.665 ± 0.0427***	15.56	Noticeable
	7	-0.514 ± 0.0563***	9.13	Noticeable
	8	0.614 ± 0.0477***	12.87	Noticeable
	9	0.478 ± 0.0590***	8.10	Moderate
	10	0.424 ± 0.0628***	6.75	Moderate
	11	0.445 ± 0.0614***	7.25	Moderate
<i>A selection index of reproductive qualities of the sow (SIRQS) score</i>	1	-0.158 ± 0.0746*	2.11	Weak
	2	-0.010 ± 0.0765	0.13	-
	3	0.040 ± 0.0764	0.52	-
	4	-0.070 ± 0.0761	0.92	-
	5	0.018 ± 0.0765	0.23	-
	6	0.985 ± 0.0022***	446.98	Very high
	7	-0.714 ± 0.0375***	19.04	High
	8	0.933 ± 0.0099***	93.95	Very high
	9	0.757 ± 0.0327***	23.13	High
	10	0.681 ± 0.041***	16.60	Noticeable
	11	-0.576 ± 0.0511***	11.27	Noticeable

Notes: 1 – age of reaching 100 kg live weight, days; 2 – body length, cm; 3 – fatback thickness at the level of 6–7 thoracic vertebrae, mm; 4 – fatback thickness on the sacrum, mm; 5 - fatback thickness in the middle point of the back, mm; 6 – fertility, hd.; 7 – high fertility, kg; 8 – index of evenness (homogeneity) of the sow's nest according to the live weight of piglets at the time of their birth (IVG₀), score; 9 – the number of piglets at the time of weaning, heads; 10 – nest weight at the time of weaning at the age of 28 days, kg; 11 – preservation, %; ** – P < 0.01, *** – P < 0.001

Studies have shown that the correlation coefficient ranges from -0.714 ($tr = 19.04$) to $+0.985$ ($tr = 446.98$). The number of reliable correlations between the signs of own productivity of repair sows, reproductive qualities of sows, and the BLUP index (maternal line), and therefore the selection index of reproductive qualities of the sow

(SIRQS) is 81.81 and 63.63% , respectively.

The results of calculating the economic efficiency of using sows of different breeding values, assessed by the BLUP method (maternal line) and the selection index of reproductive qualities of the sow (SIRQS), are shown in Table 6.

Table 6

The economic efficiency of using sows of different breeding values, evaluated by the BLUP method (maternal line) and the selection index of reproductive qualities of the sow (SIRQS)

Group	n	Nest weight at the time of weaning at the age of 28 days, kg	Increase in additional products, %	Cost of additional products, UAH / USD / head.*
General selection	171	76.7 ± 0.74	-	-
<i>intrabreed differentiation according to the BLUP index (maternal line)</i>				
III	38	70.2 ± 1.75	-8.47	-304.03 / -7.69
II	100	77.2 ± 0.84	+0.50	+17.94 / +0.45
I	33	82.2 ± 1.38	+6.69	+240.14 / +6.07
<i>intrabreed differentiation according to the selection index of reproductive qualities of the sow (SIRQS)</i>				
III	34	65.4 ± 1.42	-14.73	-528.74 / -13.38
II	99	77.6 ± 0.76	+1.15	+41.27 / +1.04
I	38	84.2 ± 1.03	+8.90	+319.47 / +8.08

Note: * – the average selling price of young pigs to processing enterprises is 62.4 UA hryvnias or 1.57 US dollars per 1 kg of live weight

Calculations of the economic efficiency of the research results show that the maximum increase in additional production was obtained from sows of the first experimental group of intrabreed differentiation according to the BLUP index (maternal line) (+6.69 %). According to the selection index of reproductive qualities of the sow (SIRQS) (+8.90 %): it costs +240.14 – +319.47 UAH or +6.07 – +8.08 US dollars, obtained from 1 animal for one farrowing.

Conclusions

It was established that repair pigs of the large white breed of the controlled population belong to the elite class according to their productivity (age of reaching a live weight of 100 kg, days; fatback thickness at the level of 6–7 thoracic vertebrae, mm).

The maximum indicators of multiple fertility ($12.5 \pm 0.24 - 13.1 \pm 0.16$ heads), the number of piglets at the time of weaning ($10.5 \pm 0.17 - 10.8 \pm 0.14$ heads), and nest weight at the time of weaning at the age of 28 days ($82.2 \pm 1.38 - 84.2 \pm 1.03$ kg) sows of the first experimental group of intrabreed differentiation were characterized by the BLUP index (maternal line) and by the selection index of reproductive qualities of the sow (SIRQS). The maximum indicator of high fertility ($1.35 \pm 0.021 - 1.38 \pm 0.018$ kg) and the minimum value of the index of evenness (homogeneity) of the sow's nest by live weight of piglets at the time of their birth (IVH₀) ($4.11 \pm 0.202 - 3.52 \pm 0.128$ score) was found in sows of the III sub-experimental group.

The coefficient of variation (Cv, %) of the reproductive qualities of sows of the large white breed of different breeding value, assessed by the BLUP index (maternal line) and the selection index of the reproductive qualities of the sow (SIRQS) ranges from 5.08 ± 0.625 to 25.83 ± 2.965 %.

The coefficient of pairwise correlation (r) between the characteristics of own productivity of repair pigs, reproductive qualities of sows, the BLUP index (maternal line), and the selection index of reproductive qualities of the sow (SIRQS) ranges from -0.714 ($tr = 19.04$) to $+0.985$ ($tr = 446.98$).

The use of sows of high breeding value, evaluated according to the BLUP index (maternal line) and the selection index of reproductive qualities of the sow (SIRQS) (I sub-experimental group), provides additional production at the level of +6.69 – +8.08 %, and its value is +240.14 – +319.47 UAH or +6.07 – +8.08 US dollars

The criterion for selecting highly productive animals of controlled populations according to the BLUP index (maternal line) is an indicator of 111.53–165.23 points, and the selection index of reproductive qualities of the sow (SIRQS) is 95.03–115.08 points.

Conflict of interest

The authors declare no conflict of interest.

References

- Ahapova, Ye. M., & Susol, R. L. (2015). Generalization of the breeding and technological bases of the creation and practical use of the promising genotype of pigs of the Odesa region. Herald of Agrarian Science of the Black Sea Region, 2(2), 63–70.
- Akimov, O. V. (2010). Intensity of growth of purebred and purebred young pigs. Herald of Agrarian Science of the Black Sea Region, 1(52), 131–135.
- Getya, A., Nagy, I., Berezovskyy, M., Kodak, O., Farkas, J., & Szaby, C. (2010). Estimation of genetic trend for the back fatback depth of pigs of Large White breed in two Ukrainian pedigree 12 farm. Proceeding of the 18th International Symposium “Animal Science Days”. 21–24 Sept. Kaposvar, 214.

- Hryshyna, L. P., & Fesenko, O. H. (2015). The efficiency of using a specialized type of pig for crossbreeding and hybridization. *Herald of Agrarian Science of the Black Sea Region*, 2(84), 40–47.
- Instructions on the sounding of pigs; Instructions for keeping pedigree records in pig breeding. Kyiv: “Kyiv University”, 2003. 64 p.
- Khalak, V. I. (2015). Mathematical models for determining the alignment of the nest of sows and their zootechnical assessment. *Bioresources and nature management*, 7(1-2), 103–109.
- Khalak, V. I., Gutyj, B. V., Il'chenko, M. O., & Smyslov, S. U. (2021). Variability and associative relationship of some biochemical indicators of blood serum and physical-chemical properties of Large White breed stores' muscle tissue. *Bulletin of Poltava State Agrarian Academy*, 2, 152–157. DOI: 10.31210/visnyk2021.02.18.
- Khalak, V., & Gutyj, B. (2020). Signs of reproductive qualities of sows of different types of adaptation, their variability and correlation. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 22(92), 35–41. DOI: 10.32718/nvlvet-a9207.
- Khalak, V., Bankovska, I., & Gutyj, B. (2022). Pig biology: serum enzymes and their correlation with physicochemical properties and chemical composition of muscle tissue. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 24(97), 92–98. DOI: 10.32718/nvlvet-a9716.
- Khalak, V., Dudchak, I., Gutyj, B., Stadnytska, O., Vakulik, V., Pundiak, T., Zmiia, M., Slepokura, O., Bordun, O., & Smyslov, S. (2021). Some biochemical indicators of serum, fattening, and meat quality of young pigs of different classes of distribution according to the Sazer-Fredin index. *Ukrainian Journal of Ecology*, 11(7), 6–13. DOI: 10.15421/2021_236.
- Khalak, V., Gutyj, B., & Bordun, O. (2022). Innovative methods of evaluation of sows by indicators of reproductive qualities and criteria for their selection by some multicomponent mathematical models. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 24(96), 70–77. DOI: 10.32718/nvlvet-a9609.
- Khalak, V., Gutyj, B., & Denysiuk, O. (2022). Some parameters of the interior and productivity of young beef cattle. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 24(96), 131–138. DOI: 10.32718/nvlvet-a9618.
- Khalak, V., Gutyj, B., Bordun, O., Stadnytska, O., & Ilchenko, M. (2021). The biochemical indicators of blood serum and their relationship with fattening and meat qualities of young swine of different inbred differentiation according to the sazer-fredin index. *Scientific Papers. Series D. Animal Science, LXIV(2)*, 70–75. URL: https://animalsciencejournal.usamv.ro/pdf/2021/issue_2/Art9.pdf.
- Khalak, V., Gutyj, B., Il'chenko, M., Shostya, A., Usenko, S., & Petulko, P. (2022). Efficiency of using some polycomponent mathematical models of selection indices for evaluation of young pigs for fattening and meat qualities. *Bulletin of Poltava State Agrarian Academy*, 2, 197–204. DOI: 10.31210/visnyk2022.02.23.
- Khalak, V., Gutyj, B., Stadnytska, O., Shuvar, I., Balkovskiy, V., Korpita, H., Shuvar, A., & Bordun, O. (2021). Breeding value and productivity of sows of the Large White breed. *Ukrainian Journal of Ecology*, 11(1), 319–324. DOI: 10.15421/2021_48.
- Koivula, M., Strandén, I., Su, G., & Mäntysaari, E. (2012). Different methods to calculate genomic predictions – Comparisons of BLUP at the single nucleotide polymorphism level (SNP-BLUP), BLUP at the individual level (G-BLUP), and the onestep approach (H-BLUP). *Journal of dairy science*, 95(7), 4065–4073. DOI: 10.3168/jds.2011-4874.
- Kovalenko, V. P., Khalak, V. I., Nezhlukchenko, T. I., & Papakina, N. S. (2010). *Biometric analysis of the variability of traits of agricultural animals and poultry. Educational manual on the genetics of agricultural animals*. Kherson: Oldi.
- Kramarenko, S., Lugovoy, S., Lykhach, A., Kramarenko, A., Lykhach, V., & Slobodanyk, A. (2019). Effect of genetic and non-genetic factors on the reproduction traits in Ukrainian Meat sows. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 21(90), 3–8. DOI: 10.32718/nvlvet-a9001.
- Kremez, M., Povod, M., Mykhalko, O., Susol, R., Trybrat, R., Onishenko, L., Kravchenko, O., Verbelchuk, T., & Sherbyna, O. (2022). Reproductive characteristics of pigs of Irish selection and manifestation of different forms of heterosis by different methods of breeding in modern conditions of industrial pork production. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 24(96), 78–88. DOI: 10.32718/nvlvet-a9610.
- Martyniuk, I. M., Tsereniuk, O. M., & Akimov, O. V. (2019). Fertility and multiple fertility of sows depending on the frequency of insemination in different seasons. *Scientific and technical bulletin of the Animal Husbandry Institute of the National Academy of Sciences*, 121, 156–162. DOI: 10.32900/2312-8402-2019-121-156-162.
- Nebylytsia, M. S. (2013). Evaluation of pigs by the BLUP method in breeding farms of the Cherkasy region. *Bulletin of the Poltava State Agrarian Academy*, 3, 110–113.
- Povod, M., Mykhalko, O., Gutyj, B., Mironenko, O., Verbelchuk, S., Koberniuk, V., & Tkachuk, O. (2022). Dependence of the microclimate parameters of the pig house on different frequency of manure pits emptying and outdoor temperature. *Scientific Papers. Series “Management, Economic Engineering in Agriculture and rural development”*, 22(4), 603–616. URL: https://managementjournal.usamv.ro/pdf/vol.22_4/Art65.pdf.
- Povod, M., Mykhalko, O., Povochnikov, M., Gutyj, B., Koberniuk, V., Shuplyk, V., Ievstafieva, Y., & Buchkovska, V. (2022). Efficiency of using high-protein sunflower meal instead of soybean meal in feeding of growing piglets. *Scientific Papers. Series “Management, Economic Engineering in Agriculture and rural development”*, 22(4), 595–602. URL: https://managementjournal.usamv.ro/pdf/vol.22_4/Art64.pdf.

- Povod, M., Mykhalko, O., Verbelchuk, T., Gutyj, B., Borshchenko, V., & Koberniuk, V. (2023). Productivity of sows, growth of piglets and fattening qualities of pigs at different durations of the suckling period. *Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development"*, 23(1), 649–658. URL: https://managementjournal.usamv.ro/pdf/vol.23_1/Art68.pdf.
- Sameliuk, Y., Kaplaushenko, A., Nedorezaniuk, N., Ostretsova, L., Diakova, F. & Gutyj, B. (2022). Prospects for the search for new biologically active compounds among the derivatives of the heterocyclic system of 1,2,4-triazole. *Hacettepe University Journal of the Faculty of Pharmacy* 42 (3), 175–186. DOI: 10.52794/hujpharm.1019625.
- Sidorova, A. V., Leonova, N. V., Masich, L. A., Skorobogatova, N. V. & Shamileva, L. L. (2003). *Practicum on the theory of statistics*. Donetsk: Donetsk National University.
- Simonov, M., Stronskyi, I., Salata, V., Stronskyi, Y., Kladnytska, L., Kukhtyn, M., Tomchuk, V., Kozytska, T., & Tokarchuk, T. (2022). The effect of transportation and pre-slaughter detention on quality of pig meat. *Potravinarstvo Slovak Journal of Food Sciences*, 16, 80–91. DOI: 10.5219/1699.
- Tsereniuk, O. M., Akimov, O. V., Babich, M., & Kropivets-Domanska, K. (2021). Analysis of the reproductive qualities of Landrace and Welsh pigs in subjects of the breeding business of Ukraine. *Scientific and technical bulletin of the Animal Husbandry Institute of the National Academy of Sciences*, 125, 227–237. DOI: 10.32900/2312-8402-2021-125-227-237.
- Tsereniuk, O. M., Khvatov, F. I., & Stryzhak, T. A. (2010). Effectiveness of breeding and evaluation indices of maternal productivity of pigs. *Scientific and technical bulletin of the National Academy of Sciences*, 102, 173–183.
- Vashchenko, P. A., Balatsky, V. N., & Pochernyaev, K. F. (2015). Using the BLUP model with the inclusion of DNA markers to evaluate pigs. *Zootechnical science of Belarus: Collection of scientific papers. Zhodino*, 50(1), 43–50.