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REPRODUCTIVE PERFORMANCE OF FRENCH-LINE LARGE WHITE SOWS AND THE RESULTS OF THEIR EVALUATION USING SELECTED MATHEMATICAL MODELS OF SELECTION INDICES

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The paper presents the results of studies on the reproductive performance of French-line Large White sows using novel index selection methods. The research was conducted at the pedigree breeding farm for Large White pigs of LLC "Agroprime Holding" (Odesa Region, Ukraine) and at the Laboratory of Pig Breeding and Selection of the Institute of Pig Breeding and Agro-Industrial Production of the National Academy of Agrarian Sciences of Ukraine during 2024–2025.

It was established that French-line Large White sows are characterized by high reproductive performance. The litter size averaged 12.4 piglets (CV = 13.71%), the number of piglets at weaning at 28 days of age was 11.6 piglets (CV = 8.58%), litter weight at weaning at 28 days of age was 89.8 kg (CV = 10.55%), litter weight at weaning at 60 days of age was 237.6 kg (CV = 10.35%), and piglet survival rate to weaning at 28 days of age was 92.1 ± 0.45%. The Yu. D. Shatalina Index (I) was 74.83 points (CV = 9.89%), while the Selection Index of Reproductive Qualities of Sows (SIRQS) was 103.38 points (CV = 12.46%).

A significant difference among animals of different intrabreed differentiation groups according to the Yu. D. Shatalina Index (I) and the Selection Index of Reproductive Qualities of Sows (SIRQS) (Groups I, II, and III) was found for litter size, the number of piglets at weaning at 28 days of age, and litter weight at weaning at 28 and 60 days of age. The difference between animals of the specified groups according to the Yu. D. Shatalina Index amounted to 8.94 (td = 8.67) and 18.21 points (td = 15.97). In contrast, according to the Selection Index of Reproductive Qualities of Sows (SIRQS) it was 14.51 (td = 7.75) and 31.78 points (td = 14.577), respectively.

The pairwise correlation coefficients between the Yu. D. Shatalina Index, the Selection Index of Reproductive Qualities of Sows (SIRQS), and reproductive traits in French-line Large White sows were highly significant. They ranged from –0.805 (tr = 14.45) to +0.992 (tr = 393.41).

The criterion for selecting highly productive sows within the monitored population is a Yu. D. Shatalina Index value ranging from 80.02 to 89.84 points, while for the Selection Index of Reproductive Qualities of Sows (SIRQS), the corresponding range is 112.16 to 129.63 points.

Keywords: sow, breed, selection, reproductive performance, selection index, variability, correlation.

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ВІДТВОРЮВАЛЬНІ ЯКОСТІ СВИНОМАТОК ВЕЛИКОЇ БІЛОЇ ПОРОДИ ФРАНЦУЗЬКОЇ СЕЛЕКЦІЇ ТА РЕЗУЛЬТАТИ ЇХ ОЦІНКИ ЗА ДЕЯКИМИ МАТЕМАТИЧНИМИ МОДЕЛЯМИ СЕЛЕКЦІЙНИХ ІНДЕКСІВ

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В роботі наведено результати досліджень відтворювальних якостей свиноматок великої білої породи французької селекції з використанням нових методів індексної селекції. Роботу виконано в племінному заводі з розведення свиней великої білої породи ТОВ «Агропрайм Холдинг» Одеської області та лабораторії розведення та селекції свиней Інституту свинарства і АПВ НААН (2024-2025 рр.).

Установлено, що свиноматки великої білої породи французької селекції характеризуються високими показниками відтворювальних якостей. Багатоплідність тварин становить 12,4 гол (Cv=13,71 %), кількість поросят на час відлучення у віці 28 діб – 11,6 гол (Cv=8,58 %), маса гнізда на час відлученні у віці 28 діб – 89,8 кг Cv=10,55 %), маса гнізда на час відлученні у віці 60 діб – 237,6 кг (Cv=10,35 %), збереженість поросят до відлучення у віці 28 діб – 92,1±0,45 %; індекс Ю. Д. Шаталіної (І) дорівнює 74,83 бала (Cv=9,89 %), селекційний індекс відтворювальних якостей свиноматки (СІВЯС) – 103,38 бала (Cv=12,46 %). Достовірну різницю між тваринами різної внутріпородної диференціації за індексом Ю. Д. Шаталіної (І) та селекційним індексом відтворювальних якостей свиноматки (СІВЯС) (І, ІІ і ІІІ піддослідні групи) установлено за багатоплідністю, кількістю поросят на час відлучення у віці 28 діб, масою гнізда на час відлучення у віці 28 і 60 діб. Різниця між тваринами зазначених груп за індексом Ю. Д. Шаталіної становить 8,94 (td=8,67) і 18,21 бала (td=15,97), за селекційним індексом відтворювальних якостей свиноматки (СІВЯС) – 14,51 (td=7,75) і 31,78 бала (td=14,577). Коефіцієнти парної кореляції між індексом Шаталіної Ю. Д., селекційним індексом відтворювальних якостей свиноматки (СІВЯС) та показниками відтворювальних якостей у свиноматок великої білої породи французької селекції є високодостовірними і коливаються у межах від –0,805 (tr=14,45) до +0,992 (tr=393,41).

Критерієм відбору високопродуктивних свиноматок для підконтрольної популяції за індексом Шаталіної Ю. Д. є його значення на рівні 80,02-89,84 бала, за селекційним індексом відтворювальних якостей свиноматки (СІВЯС) – 112,16-129,63 бала.

Ключові слова: свиноматка, порода, селекція, відтворювальні якості, селекційний індекс, мінливість, кореляція

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Introduction. The results of studies conducted by Ukrainian and international researchers indicate that accelerating genetic improvement in pig breeding requires the application of breeding value assessment methods that enable the selection of highly productive animals suitable for intensive commercial production systems (Hetia, 2009; Mykhalko, Povod, & Andriichuk, 2021; Khalak, Hutyi, Usenko, & Shostia, 2021).

Kremez et al. (2022) reported that, under crossbreeding conditions, hybrid litters outperformed purebred litters of the maternal line in terms of reproductive performance. At farrowing, hybrid litters exceeded purebred counterparts by 3.9% and 2.2% in potential and actual litter size, respectively, while litter weight at birth and individual piglet birth weight were higher by 6.3% and 6.8%, respectively. At weaning, the advantages of hybrid litters amounted to 1.7–2.0% for piglet survival, 5.7–6.5% for the number of piglets weaned, 8.5% for litter weight, and 4.2% for individual piglet body weight. Comprehensive evaluation of sows using the Selection Index of Reproductive Qualities of Sows (SIRQS) and the Reproductive Performance Index demonstrated the superiority of hybrid litters over purebred ones by 3.9% and 3.3%, respectively.

Studies by Ukrainian researchers have shown that sows with SIRQS values ranging from 97.59 to 115.40 points significantly outperform their contemporaries with SIRQS values of 90.37–96.62 and 64.07–89.57 points in litter size by 1.0–2.4 piglets, milk production by 2.5–4.0 kg, number of piglets at weaning (30 days of age) by 0.7–1.2 piglets, litter weight at 30 days by 2.7–3.7 kg, and litter weight at 60 days by 8.7–13.4 kg. The pairwise correlation coefficients between SIRQS and reproductive traits ranged from –0.618 ($tr = 9.38$; $P > 0.001$) to +0.935 ($tr = 69.73$; $P < 0.001$), with all correlations being statistically significant. Furthermore, the highest increase in additional production was obtained from sows of the first experimental group (+2.48%), corresponding to an economic benefit of UAH 101.34 per sow per farrowing. Therefore, a SIRQS value of 97.59–115.40 points has been proposed as a criterion for selecting highly productive sows within the studied population (Khalak et al., 2025).

According to Sukhno (2024), the Berezovskyi Selection Index was significantly affected by both feeding regime ($F = 5.80$, $p = 0.02$) and genotype ($F = 12.85$, $p = 0.001$), as well as by their interaction ($F = 8.56$, $p = 0.005$). The Tyler Selection Index was significantly influenced by the genotype of the experimental animals ($F = 22.31$, $p < 0.001$). The author reported that growth intensity and growth uniformity indices were lowest in pigs carrying the MC4RGA genotype under restricted feeding conditions. This group also exhibited the lowest average daily gains and the poorest selection index values, indicating that growth intensity and uniformity parameters may be useful for the preliminary selection of superior animals during early ontogeny.

The effectiveness of index selection methods in pig breeding has also been confirmed by numerous studies conducted by Ukrainian and foreign researchers (Khalak, Tsereniuk, Khmelnychyi et al., 2025; Khalak, Bordun, Hutyi et al., 2026; Povod et al., 2023; Sukhno et al., 2022; Alfonso, 2019).

Aim of the Study. The aim of this study was to investigate the reproductive performance of French-line Large White sows and, based on the obtained data, to perform a comprehensive evaluation of the animals using index selection methods.

Materials and Methods. The research and data analysis were carried out at the pedigree breeding farm of LLC “Agroprime Holding” (Odesa Region, Ukraine), specializing in the breeding of Large White pigs, and at the Laboratory of Pig Breeding and Selection of the Institute of Pig Breeding and Agro-Industrial Production of the National Academy of Agrarian Sciences of Ukraine.

The evaluation of French-line Large White sows was performed using the following quantitative traits: total number of piglets born per litter (litter size, head),

number of piglets at weaning at 28 days of age (head), litter weight at weaning at 28 days of age (kg), litter weight at weaning at 60 days of age (kg), and piglet survival rate to weaning (%).

Litter weight at 60 days of age was determined using a calculation method. For this purpose, correction coefficients for adjusting litter weight to 60 days of age were applied according to the recommendations of the ***Instructions for Pig Bonitation*** (2003), Khalak (2009), and Khalak et al. (2022) (Table 1).

Table 1

Correction coefficients for adjusting piglet litter weight at weaning to the standard age of 60 days

Weaning age, days	Coeffi cient	Weaning age, days	Coeffi-cient	Weaning age, days	Coeffi-cient	Weaning age, days	Coeffi-cient
21	3.000	31	2.428	41	1.708	51	1.275
22	2.976	32	2.356	42	1.656	52	1.250
23	2.952	33	2.284	43	1.604	53	1.225
24	2.928	34	2.212	44	1.552	54	1.200
25	2.904	35	2.140	45	1.500	55	1.150
26	2.880	36	2.064	46	1.460	56	1.120
27	2.804	37	1.988	47	1.420	57	1.090
28	2.728	38	1.912	48	1.380	58	1.060
29	2.652	39	1.836	49	1.340	59	1.030
30	2.500	40	1.760	50	1.300	60	1.000

A comprehensive evaluation of sow reproductive performance was carried out using the Yu. D. Shatalina Index (I) (Equation 1) and the Selection Index of Reproductive Qualities of Sows (SIRQS) (Equation 2). These indices were calculated according to the following mathematical models:

$$I = (1{,}27 \times X_1) + (2{,}74 \times X_2) + (0{,}304 \times X_3) \quad (1)$$

where:

- I – Yu. D. Shatalina Index, points;
- X_1 – total number of piglets born (litter size), head;
- X_2 – number of piglets at weaning, head;
- X_3 – litter weight at 60 days of age, kg (Vashchenko, 2019).

$$SIRQS = (6 \times X_1) + \left[9{,}34 \times \left(\frac{X_2}{X_3}\right) \right] \quad (2)$$

where:

- **SIRQS** – Selection Index of Reproductive Qualities of Sows, points;
- **X_1** – litter size (total number of piglets born), head;
- **X_2** – litter weight at weaning, kg;
- **X_3** – age of piglets at weaning, days (Tsereniuk, Khvatov, & Stryzhak, 2010; Akimov et al., 2023).

Results and Discussion. The analysis of primary zootechnical records and the results of our own investigations indicate that French-origin Large White sows (n = 40) were characterized by high reproductive performance. Litter size averaged 12.4 ± 0.26 piglets (CV = 13.71%), the number of piglets at weaning at 28 days of age was 11.6 ±

0.15 head (CV = 8.58%), litter weight at weaning at 28 days of age was 89.8 ± 1.49 kg (CV = 10.55%), litter weight at 60 days of age was 237.6 ± 3.88 kg (CV = 10.35%), and piglet survival to weaning at 28 days of age reached 92.1 ± 0.45%.

The average value of the Yu. D. Shatalina Index (I) was 74.83 ± 1.169 points (CV = 9.89%), whereas the Selection Index of Reproductive Qualities of Sows (SIRQS) averaged 103.38 ± 2.036 points (CV = 12.46%).

The results of the evaluation of reproductive traits in French-origin Large White sows differentiated according to the Yu. D. Shatalina Index (I) and the Selection Index of Reproductive Qualities of Sows (SIRQS) are presented in Tables 2 and 3.

The analysis of reproductive traits in sows classified according to the Yu. D. Shatalina Index (I) (Table 2) revealed significant differences among animals of the first, second, and third experimental groups. The differences between sows of Groups I and III amounted to 1.6 (td = 5.71; P < 0.001) and 3.8 piglets (td = 10.85; P < 0.001) for litter size, respectively. The corresponding differences in the number of piglets at weaning at 28 days of age were 1.2 (td = 6.00; P < 0.001) and 2.6 piglets (td = 11.81; P < 0.001).

Table 2

Reproductive performance of French-origin Large White sows classified according to the Yu. D. Shatalina Index (I)

Indicators, units of measurement	**Statistical parameters**	**Yu. D. Shatalina Index (I), points**		
		80,02-89,84	**71,02-79,33**	**60,77-69,36**
		Group		
		I	**II**	**III**
	n	10	17	13
Litter size, head	*X*±*Sx*	14,3±0,24	12,7±0,16	10,5±0,26
	C_v±S_{Cv}, %	5,43±1,214	5,43±0,931	9,04±1,776
Difference from Elite Class, head	-	*+3,3*	*+1,7*	*-0,6*
Number of piglets at weaning (28 days), head	*X*±*Sx*	12,8±0,19	11,6±0,08	10,2±0,12
	C_v±S_{Cv}, %	4,72±1,055	3,16±0,542	4,30±0,844
Litter weight at weaning (28 days), kg	*X*±*Sx*	102,2±1,23	90,4±0,96	79,5±1,11
	C_v±S_{Cv}, %	3,83±0,856	4,38±0,751	5,04±0,990
Litter weight at 60 days of age, kg	*X*±*Sx*	270,9±3,48	237,3±2,55	212,3±2,86
	C_v±S_{Cv}, %	4,06±0,908	4,44±0,761	4,86±0,954
Difference from Elite Class, kg	-	*+90,9*	*+57,3*	*+32,3*
Piglet survival to weaning (28 days), %	*X*±*Sx*	89,5±0,52	91,3±0,43	97,1±0,78
Yu. D. Shatalina Index, points	*X*±*Sx*	84,55±0,876	75,61±0,559	66,34±0,747
	C_v±S_{Cv}, %	3,28±0,733	3,05±0,523	4,06±0,797

For litter weight at weaning at 28 days of age, the differences reached 4.3 kg (td = 2.77; P < 0.01) and 22.7 kg (td = 13.75; P < 0.01), while for litter weight adjusted to 60

days of age they amounted to 33.6 kg (td = 7.79; P < 0.001) and 58.6 kg (td = 13.02; P < 0.01), respectively.

The differences in the Yu. D. Shatalina Index (I) between the respective groups were 8.94 points (td = 8.67; P < 0.001) and 18.21 points (td = 15.97; P < 0.001), indicating a high level of differentiation of reproductive performance among the studied animals.

The highest piglet survival rate to weaning at 28 days of age (97.1 ± 0.78%) was recorded in sows of Group III. The differences for this trait compared with Groups II and I amounted to 5.8% (td = 6.59; P < 0.001) and 7.6% (td = 8.17; P < 0.001), respectively.

The results of the evaluation of reproductive traits in French-origin Large White sows classified according to the Selection Index of Reproductive Qualities of Sows (SIRQS) are presented in Table 3.

Table 3

Reproductive performance of French-origin Large White sows classified according to the Selection Index of Reproductive Qualities of Sows (SIRQS)

Indicators, units of measurement	**Statistical parameters**	**Selection Index of Reproductive Qualities of Sows (SIRQS), points**		
		112,16-129,63	**97,43-111,83**	**78,06-93,04**
		Group		
		I	**II**	**III**
	n	11	18	11
Litter size, head	*X*±*Sx*	14,3±0,20	12,5±0,14	10,5±0,22
	C_v±S_{Cv}, %	4,85±1,034	4,76±0,793	7,24±1,543
Difference from Elite Class, head	-	*+3,3*	*+1,5*	*-0,8*
Number of piglets at weaning (28 days), head	*X*±*Sx*	12,8±0,15	11,5±0,10	10,1±0,14
	C_v±S_{Cv}, %	4,12±0,878	3,92±0,653	4,57±0,974
Litter weight at weaning (28 days), kg	*X*±*Sx*	99,9±2,36	90,3±1,27	78,8±1,04
	C_v±S_{Cv}, %	6,64±1,415	6,00±1,00	4,39±0,936
Litter weight at 60 days of age, kg	*X*±*Sx*	265,1±5,72	237,3±3,07	210,5±2,49
	C_v±S_{Cv}, %	7,16±1,415	5,48±0,913	3,93±0,837
Difference from Elite Class, kg	-	*+85,1*	*+57,3*	*+30,5*
Piglet survival to weaning (28 days), %	*X*±*Sx*	89,5±0,50	92,0±0,42	96,2±0,46
Reproductive Qualities of Sows (SIRQS), points	*X*±*Sx*	118,67±1,546	104,16±1,059	86,89±1,544
	C_v±S_{Cv}, %	4,32±0,921	4,31±0,718	5,90+1,085

Analysis of the primary zootechnical records and the results of our investigations demonstrated that sows of Group I significantly outperformed their counterparts from Groups II and III in all major reproductive traits. In particular, the superiority of Group I animals amounted to 1.8 (td = 7.50; P < 0.001) and 3.8 piglets (td = 13.10; P < 0.001) for litter size, respectively. The corresponding differences in the number of piglets at weaning at 28 days of age were 1.3 (td = 7.64; P < 0.001) and 2.7 piglets (td = 13.50; P < 0.001).

Regarding litter weight at weaning at 28 days of age, Group I exceeded Groups II and III by 9.6 kg (td = 3.59; P < 0.001) and 21.1 kg (td = 8.21; P < 0.001), respectively. For litter weight adjusted to 60 days of age, the corresponding differences were 27.8 kg (td = 4.28; P < 0.001) and 54.6 kg (td = 8.76; P < 0.01).

The superiority of Group I sows according to the Selection Index of Reproductive Qualities of Sows (SIRQS) amounted to 14.51 points (td = 7.75; P < 0.001) and 31.78 points (td = 14.57; P < 0.001) compared with Groups II and III, respectively.

The difference in piglet survival rate to weaning at 28 days of age between sows of Groups III, II, and I amounted to 4.2% (td = 6.77; P < 0.001) and 6.7% (td = 10.00; P < 0.001), respectively.

The biometric analysis revealed highly significant relationships between the Yu. D. Shatalina Index (I), the Selection Index of Reproductive Qualities of Sows (SIRQS), and the reproductive traits of French-origin Large White sows. The pairwise correlation coefficients ranged from –0.805 (tr = 14.45) to +0.992 (tr = 393.41), indicating strong associations between the evaluated indices and reproductive performance traits (Table 4).

Table 4

Correlation coefficients between the Yu. D. Shatalina Index (I), the Selection Index of Reproductive Qualities of Sows (SIRQS), and reproductive traits in French-origin Large White sows

Trait		**Biometric parameters**		
x	***y***	**r±Sr**	**tr**	**P**
Yu. D. Shatalina Index (I), points	Litter size, head	+0,957±0,0133***	71,87	P<0,001
	Number of piglets at weaning (28 days of age), head	+0,957±0,0133***	71,87	P<0,001
	Litter weight at weaning (28 days of age), kg	+0,944±0,0172***	54,80	P<0,001
	Litter weight at 60 days of age, kg	+0,931±0,0211***	44,16	P<0,001
	Piglet survival rate to weaning at 28 days of age, %	-0,752±0,0687***	10,94	P<0,001
Selection Index of Reproductive Qualities of Sows (SIRQS), points	Litter size, head	+0,992±0,0025***	393,41	P<0,001
	Number of piglets at weaning (28 days of age), head	+0,916±0,0255***	35,97	P<0,001
	Litter weight at weaning (28 days of age), kg	+0,903±0,0292***	30,92	P<0,001
	Litter weight at 60 days of age, kg	+0,901±0,0298***	30,26	P<0,001
	Piglet survival rate to weaning at 28 days of age, %	-0,805±0,0557***	14,45	P<0,001

The proportion of significant correlations between the Yu. D. Shatalina Index (I), the Selection Index of Reproductive Qualities of Sows (SIRQS), and the reproductive traits of French-origin Large White sows amounted to 100.0%. This finding confirms the

effectiveness of these indices for evaluating sows within the studied population and for selecting animals belonging to the elite breeding group.

Conclusions:

1. It was established that French-origin Large White sows are characterized by high reproductive performance. Their litter size averaged 12.4 piglets (CV = 13.71%), exceeding the Elite Class standard by 1.4 piglets. The number of piglets at weaning at 28 days of age was 11.6 head (CV = 8.58%), litter weight at weaning at 28 days of age was 89.8 kg (CV = 10.55%), and litter weight at 60 days of age was 237.6 kg (CV = 10.35%), exceeding the Elite Class standard by 57.6 kg. Piglet survival rate to weaning at 28 days of age reached 92.1 ± 0.45%. The average value of the Yu. D. Shatalina Index (I) was 74.83 points (CV = 9.89%), whereas the Selection Index of Reproductive Qualities of Sows (SIRQS) averaged 103.38 points (CV = 12.46%).
2. Significant differences among animals of different intrabreed differentiation groups according to the Yu. D. Shatalina Index (I) and the Selection Index of Reproductive Qualities of Sows (SIRQS) (Groups I, II, and III) were found for litter size, number of piglets at weaning at 28 days of age, and litter weight at 28 and 60 days of age. The differences between the respective groups according to the Yu. D. Shatalina Index were 8.94 points (td = 8.67) and 18.21 points (td = 15.97), whereas for SIRQS they amounted to 14.51 points (td = 7.75) and 31.78 points (td = 14.577), respectively.
3. The pairwise correlation coefficients between the Yu. D. Shatalina Index, the Selection Index of Reproductive Qualities of Sows (SIRQS), and the reproductive traits of French-origin Large White sows were highly significant and ranged from –0.805 (tr = 14.45) to +0.992 (tr = 393.41).
4. For the studied population, the criterion for selecting highly productive sows based on the Yu. D. Shatalina Index is a value ranging from 80.02 to 89.84 points. In contrast, for the Selection Index of Reproductive Qualities of Sows (SIRQS), the corresponding range is 112.16–129.63 points.

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