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ADAPTIVE AND PRODUCTIVE QUALITIES OF SOWS OF THE ½ LARGE WHITE × ½ LANDRAS MIX: EMPHASIS ON SELECTION OF HIGHLY PRODUCTIVE ANIMALS BY THE Kh2 INDEX

Abstract

The article presents the results of studies on the adaptive-productive traits of sows from the ½ Large White × ½ Landrace cross and data on calculating the economic efficiency of using them in an industrial complex. Research was carried out at the Druzhba-Kaznacheyevka agricultural enterprise in Dnipropetrovsk Oblast and in the livestock laboratory of the State Institution "Institute of Cereal Crops" of the National Academy of Agrarian Sciences (NAAS). The work was performed under NAAS research programme No. 31 "Genetic improvement of agricultural animals, their reproduction and preservation of biodiversity" (Genetics, preservation and reproduction of biological resources in livestock).It was established that sows of the ½ Large White × ½ Landrace combination have a lifespan of 38.3 months, a breeding-use duration of 28.3 months, a litter size of 10.5, and a litter mass at weaning at 28 days of 74.1 kg; their adaptive-productive quality index ranges from 21.32 to 119.57 points. A statistically significant difference between animals of different differentiation according to the adaptive-productive quality index Kh_2 was found for lifespan (18.6–28.1 months), breeding-use duration (17.5–26.5 months), number of farrowings (2.9–4.7), live piglets (33.7–53.6), litter size (0.4–0.7), litter mass at weaning at 28 days (4.6–7.1 kg) and the SIVYAS index (4.01–6.85 points).The highest piglet survival rate to weaning at 28 days (94.1 %) was observed in the third experimental group's sows. The number of significant pairwise correlation coefficients between the Kh_2 adaptive-productive index, lifespan, duration of breeding use, and the reproductive qualities of the ½ Large White × ½ Landrace sows is 50.0 %. The greatest increase in additional production was obtained from sows in the first experimental group (Kh_2 = 70.19–119.57 points); it amounted to +4.65 %, and its value equalled +240.12 UAH per head per farrowing. The selection criterion for sows with high adaptive and productive qualities is animals whose Kh_2 index is 70.19 points or more.

Keywords: *sow, breed, combination, adaptive and productive qualities, index, variability, correlation, value of additional production.*

Introduction. Among the urgent issues for developing the pig industry in Ukraine today and in the post war period are those that most effectively help increase the numbers of pigs bred for meat and improve their productive traits. In Ukraine's agricultural enterprises, this is achieved by intensifying the reproduction of domestically bred animals, introducing innovative methods for evaluating the breeding value of replacement young stock, sows, and boars, and by using pigs of foreign origin [1-15]. According to domestic researchers, these animals possess high genetic potential for key productive traits, but this potential is not always fully realized. Factors affecting this include feeding and housing conditions that do not

meet zootechnical standards, climatic influences, and insufficient adaptation in pigs of French, British, Canadian, Hungarian, Danish, and other origins.

Problem statement, analysis of current studies. Research by O. I. Dudka shows that sows of the Ukrainian Steppe Spotted breed exhibit high levels of adaptation to breeding conditions and to the environment of Ukraine's steppe zone [16]. The author notes that these animals have increased longevity and breeding use and reduced adaptation indices 40.6 months, 27.4 months, and 27.5 points, respectively. The lifespan of sows of the Ukrainian Steppe White breed was 35.7 months, their productive use age was 21.9 months, and their adaptation index was 37.7 points. It has been demonstrated that as sows age and have more farrowings, their adaptive ability index decreases, meaning these animals become better adapted to their environment. A high level of adaptability in the genotypes of the breeds studied is also confirmed by the evaluation of their working value: for each sow, the number of viable piglets totals 22.3-35.3 heads, which corresponds to the "medium" level on the scale for assessing the working value of sows.

A. I. Kyslynska notes that the adaptation process negatively affected the reproductive performance of the sows under study [17, 18]. Her research results show that the lowest values were recorded in the first-generation animals compared to the acclimatized generation. It was found that adaptation affects sow productivity: the number of non-productive returns in third-generation animals decreased by 20.7 % ($P > 0.999$), and the number of problematic farrowings almost halved. At the same time, the number of live piglets at birth increased by 7.9 % ($P > 0.95$) in third-generation sows compared with the acclimatized animals. The breeding-value index increases with each subsequent generation. The highest value was obtained in third-generation sows (419.45 units), which is 113.41 units ($P > 0.95$) higher than in the acclimatized animals. The adaptation index and annual adaptation index in third-generation animals increased by 18.02 and 13.6 units, respectively, compared with the acclimatized animals ($P > 0.999$).

Purpose of the study: to investigate the adaptive, productive, and reproductive qualities of sows of the ½ Large White × ½ Landrace combination, and based on the data obtained, to calculate the economic efficiency of their use in the conditions of an industrial complex.

Presentation of the main research material. The research was conducted at the "Druzhba-Kaznacheiivka" Limited Agricultural Company in Dnipropetrovsk Oblast and in the livestock laboratory of the State Institution "Institute of Cereal Crops" of the National Academy of Agrarian Sciences of Ukraine (NAAS). The work was carried out under NAAS research programme No. 31 "Genetic improvement of agricultural animals, their reproduction and preservation of biodiversity" (Genetics, preservation and reproduction of biological resources in livestock).

The evaluation of sows from the ½ Large White × ½ Landrace combination took into account the following quantitative traits: lifespan (months); duration of breeding use (months); total number of farrowings; total number of live piglets born; prolificacy (head); number of piglets at weaning at 30 days of age (head); litter mass at weaning at 30 days of age (kg); and piglet survival to weaning (%) [19].

The adaptive-productive qualities index (1) and the selection index for the sow's reproductive qualities (2) were calculated using the following mathematical models:

$$Kh_2 = \left[(\frac{1}{\sigma_t} \times \Delta S_1) - (\frac{1}{\sigma_p} \times \Delta D_1) \right] + N \quad (1)$$

where: Kh_2 – index of adaptive and productive qualities of the sow, points; ΔS1 – life expectancy in deviations from the mean value; ΔD1 – duration of breeding use in deviations from the mean value; σt – phenotypic standard deviation of life expectancy; σp – phenotypic standard deviation of duration of breeding use, N – total number of live piglets obtained, head [20];

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

where: SIVYAS – selection index of reproductive qualities of the sow, points; X_1 – multiparity, goal; X_2 – mass of the litter at the time of weaning, kg; X_3 – age of piglets at the time of weaning, days [21, 22].

The formation of groups was carried out by calculating the average value and the standard deviation of the Kh2 index. For animals of the I, II, and III experimental groups, this indicator was equal to X + (0.67 × σ), X ± (0.67 × σ), and X - (0.67 × σ), respectively.

The cost of additional production [23] and the main biometric indicators *(X, Sx, Cv, SCv, r, Sr, tr)* [24, 25] were calculated using generally accepted methods. The strength of correlations between the signs was determined using the Chaddock scale [26] (Table 1).

Table 1

Chaddock'sscaleforgradingthestrengthofthecorrelationbetweenquantitativetraits

Correlation coefficient value	Strengthof correlation
0,1-0,3	Weak
0,3-0,5	Moderate
0,5-0,7	Significant
0,7-0,9	High
0,9-0,99	Veryhigh

Statistical errors for the arithmetic mean (3), standard deviation (4), coefficient of variation (5), and correlation coefficient (6) were calculated using the following formulas:

$$S_x = \frac{\sigma}{\sqrt{n}} \quad (3) \qquad S_\sigma = \frac{\sigma}{\sqrt{2_n}} \quad (4) \qquad S_{Cv} = \frac{C_v}{\sqrt{2_n}} \quad (5) \qquad S_r = \frac{1 - r^2}{\sqrt{n}} \quad (3)$$

where: n is the sample size; σ is the standard deviation; Cv is the coefficient of variation; r is the correlation coefficient.

It was established that the life expectancy of sows of the ½ Large White × ½ Landrace combination is 38.3±1.24 months (Cv=29.35 %), and the duration of breeding use is 28.3±1.14 months (Cv=36.57 %). During the breeding use, 5.4±0.20 farrowings (Cv=33.84 %) were obtained from sows of the specified combination, a total of 56.1±2.00 live piglets (Cv=32.30 %). Their multiparity is 10.5±0.12 goals (Cv=10.80%), the number of piglets at the time of weaning at the age of 28 days – 9.8±0.09 goals (Cv=8.70%), the mass of the litter at the time of weaning at the age of 28 days – 77.8±0.86 kg (Cv=10.09%), the survival of piglets at the time of weaning – 90.2±0.81%. The selection index of reproductive qualities (SIVYAS) in sows of the total sample (n=82) ranges from 73.93 to 110.89, the index of adaptive and productive qualities of the sow, from 21.32 to 119.57 points.

Taking into account the differentiation of animals according to the index of adaptive and productive qualities Kh2, it was established that sows of the experimental group I (Kh_2=70.19-119.57 points) exceeded animals of the II (Kh_2= 44.23-67.62 points) and III (Kh_2= 21.32-43.94 points) in terms of life expectancy by 18.6 (td=7.26; P<0.001) and 28.1 months (td=10.80; P<0.001), in terms of duration of breeding use - by 17.5 (td=7.20; P<0.001) and 26.5 months (td=10.35; P<0.001), in terms of the number of farrowings received - by 2.9 (td=7.83; P<0.001) and 4.7 (td=11.75; P<0.001) (Table 2).

Table 2

Life expectancy, duration of breeding use, and reproductive qualities of ½ Large White × ½ Landrace sows of different differentiation by Kh_2 index

Indicators, unitsofmeasurement	Biometric indicators	Kh_2 index gradations, point		
		70,19-119,57	44,23-67,62	21,32-43,94
		Group		
		I	II	III
	n	16	48	18
Lifespan, months	$X \pm Sx$	55,3±2,43	36,7±0,83	27,2±0,95
	$\sigma \pm S_\sigma$	9,74±1,723	5,80±0,592	4,05±0,675
	$C_v \pm S_{Cv}$, %	17,61±3,116	15,80±1,613	14,88±2,480
Duration of breeding use, months	$X \pm Sx$	44,3±2,36	26,8±0,60	17,8±1,02
	$\sigma \pm S_\sigma$	9,45±1,672	4,18±0,426	4,36±0,726
	$C_v \pm S_{Cv}$, %	21,33±3,775	15,59±1,592	24,49±4,081
Farrowings received, total.	$X \pm Sx$	8,1±0,37	5,2±0,11	3,4±0,18
	$\sigma \pm S_\sigma$	1,50±0,265	0,78±0,079	0,77±0,128
	$C_v \pm S_{Cv}$, %	18,51±3,276	15,00±1,532	22,64±3,773
Total live piglets born, no.	$X \pm Sx$	88,3±3,28	54,6±0,98	34,7±1,46
	$\sigma \pm S_\sigma$	13,14±2,325	6,84±0,698	6,22±1,036
	$C_v \pm S_{Cv}$, %	14,88±2,633	12,52±1,278	17,92±3,159

Multiparity, no.	$X \pm Sx$	10,9±0,14	10,5±0,07	10,2±0,10
	$\sigma \pm S_\sigma$	1,35±0,238	1,05±0,107	1,20±0,200
	$C_v \pm S_{Cv}$, %	12,38±2,191	10,00±1,021	11,76±1,960
Number of piglets at the time of weaning at the age of 28 days, no.	$X \pm Sx$	9,6±0,16	9,7±0,12	9,6±0,22
	$\sigma \pm S_\sigma$	0,65±0,115	0,87±0,088	0,96±0,160
	$C_v \pm S_{Cv}$, %	6,77±1,198	8,96±0,915	10,00±1,667
Weight of the nest at the time of weaning at the age of 28 days, kg	$X \pm Sx$	81,6±1,84	77,0±1,07	74,5±2,07
	$\sigma \pm S_\sigma$	7,36±1,302	7,43±0,758	8,82±1,470
	$C_v \pm S_{Cv}$, %	9,01±1,594	9,64±0,984	11,83±1,971
Pigletsurvivaltoweaning, %	$X \pm Sx$	88,0±1,93	92,3±1,06	94,1±1,71
SIVYAS, score	$X \pm Sx$	94,82±1,270	90,81±1,030	87,97±1,891
	$\sigma \pm S_\sigma$	9,08±1,607	7,14±0,729	8,02±1,336
	$C_v \pm S_{Cv}$, %	9,57±1,693	7,86±0,802	9,11±1,518

The differences between the animals of the specified groups for the indicator "total live piglets born" amount to 33.7 (td = 9.85; P < 0.001) and 53.6 head (td = 14.97; P > 0.001); for "prolificacy" – 0.4 (td = 2.67; P < 0.05) and 0.7 head (td = 4.11; P < 0.001); for "litter mass at weaning at 28 days" – 4.6 (td = 2.16; P < 0.05) and 7.1 kg (td = 2.57; P < 0.05); and for the SIVYAS index – 4.01 (td = 2.46; P < 0.05) and 6.85 points (td = 3.01; P < 0.01). The highest piglet survival to weaning at 28 days (94.1 ± 1.71 %) was recorded in sows of the third experimental group. No significant differences among the experimental groups were found in the number of piglets at weaning at 28 days of age.

The biometric analysis indicates that the pairwise correlation coefficient between the "Kh_2" index, lifespan, duration of breeding use and the reproductive traits of sows of the ½ Large White × ½ Landrace combination ranges from –0.199 (tr = 1.93; P > 0.05) to +0.999 (tr = 4657.67; P < 0.001) (Table 3).

Table 3

Level of correlations between the index Kh_2, lifespan, duration of breeding use, and reproductive qualities of sowscombination ½ Large White × ½ Landrace, n=82

Sign		Biometric Indicators		Correlation Strength
x	*y*	r±Sr	tr	
Kh_2, бала	1	+0,888±0,0227***	39,14	High
	2	+0,907±0,0190***	47,66	Very High
	3	+0,931±0,0143***	65,12	Very High
	4	+0,999±0,0002***	4657,67	Very High
	5	+0,057±0,1069	0,53	-

	6	–0,124±0,1056	1,17	Weak
	7	+0,166±0,1043	1,59	Weak
	8	–0,199±0,1030	1,93	Weak

Note: *1 – life expectancy, months; 2 – duration of breeding use, months; 3 – total number of piglets received; 4 – total number of live piglets born; 5 - multiparity, number; 6 – number of piglets at the time of weaning at the age of 30 days, number; 7 – litter weight at the time of weaning at the age of 30 days, kg; 8 – survival of piglets to weaning at the age of 30 days, %; *** - P<0.001*

Significant relationships were established between the following pairs of traits: Kh_2 × life expectancy (r=+0.888, tr=39.14), Kh_2 × duration of breeding use (r=+0.907, tr=47.66), Kh_2 × total number of farrowings (r=+0.931, tr=65.12), Kh_2 × total number of live piglets born (r= +0.999, tr=4657.67).

Calculation of the economic efficiency of the research results shows that the maximum increase in additional production was obtained from sows of the first experimental group (Kh_2=70.19-119.57 points) (+4.65%) (Table 4).

Table 4

Economic efficiency of using sows of different differentiation according to the index of adaptive and productive qualities K_2

Group	Kh_2, point	Nestweightatweaningat 30 daysofage, kg	± tothepopulation mean, %	Cost of additional production, UAH / head / farrowing
III	21,32-43,94	74,5±2,07	-4,24	-218,95
II	44,23-67,62	77,0±1,07	-1,02	-52,67
I	70,19-119,57	81,6±1,84	+4,65	+240,12

Note: ** – the selling price of young pigs at the time of the experimental part of the research was 88.5 hryvnias per 1 kg of live weight*

The cost of additional production obtained from one sow of the specified group is +240.12 hryvnias / head / farrowing.

Conclusions and prospects for further research.

1. In sows of the ½ Large White × ½ Landrace combination, the lifespan is 38.3 ± 1.24 months, the duration of breeding use is 28.3 ± 1.14 months, prolificacy is 10.5 ± 0.12 piglets, and litter mass at weaning at 30 days of age is 74.1 ± 0.81 kg; the adaptive productive qualities index ranges from 21.32 to 119.57 points.

2. A significant difference between animals of different groups according to the adaptive productive qualities index Kh_2 was found in lifespan (18.6–28.1 months), duration of breeding use (17.5–26.5 months), number of farrowings obtained (2.9–4.7), number of live piglets (33.7–53.6 head), prolificacy (0.4–0.7 head), litter mass at weaning at 28 days (4.6–7.1 kg) and the SIVYAS index (4.01–

6.85 points). The highest piglet survival to weaning at 28 days (94.1 ± 1.71 %) was observed in sows of the third experimental group.

3. The proportion of significant pairwise correlation coefficients among the adaptive productive qualities index Kh_2, lifespan, duration of breeding use, and reproductive qualities of the ½ Large White × ½ Landrace sows is 50.0 %.

4. The greatest increase in additional production was obtained from sows of the first experimental group (Kh_2 = 70.19–119.57 points). It amounted to +4.65 %, and its monetary value was +240.12 UAH per head per farrowing.

5. Animals with a Kh_2 index of 70.19 points or higher should be selected as sows with high adaptive and productive qualities.

Prospects for further research. Further work involves conducting studies of the signs of long-term adaptation and reproductive qualities of sows of foreign selection, taking into account their differentiation by some genetic markers.

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АДАПТИВНІ ТА ПРОДУКТИВНІ ЯКОСТІ СВИНОМАТОК ПОЄДНАННЯ½ ВЕЛИКА БІЛА × ½ ЛАНДРАС: АКЦЕНТ НА ВІДБІР ВИСОКОПРОДУКТИВНИХ ТВАРИН ЗА ІНДЕКСОМ Kh_2

Анотація

В статті наведено результати досліджень адаптивно-продуктивних якостей свиноматок поєднання ½ велика біла × ½ ландрас, а також даних розрахунку економічної ефективність їх використання в умовах промислового комплексу. Дослідження проведено в СТОВ «Дружба-Казначеївка» Дніпропетровської області, а також в лабораторії тваринництва ДУ Інститут зернових культур НААН. Роботу виконано згідно ПНД НААН №31 «Генетичне поліпшення сільськогосподарських тварин, їх відтворення та збереження біорозмаїття». (Генетика, збереження та відтворення біоресурсів у тваринництві). Установлено, що у свиноматок поєднання ½ велика біла × ½ ландрас тривалість життя

становить 38,3 міс, тривалість племінного використання – 28,3 міс, багатоплідність – 10,5 гол, маса гнізда на час відлучення у віці 28 діб – 74,1 кг; індекс адаптивно-продуктивних якостей коливається у межах від 21,32 до 119,57 балів. Достовірну різницю між тваринами різної диференціації за індексом адаптивно-продуктивних якостей Kh_2 установлено за тривалістю життя (18,6-28,1 міс), тривалістю племінного використання (17,5 – 26,5 міс), кількістю одержаних опоросів (2,9 – 4,7), живих поросят (33,7 – 53,6 гол), багатоплідністю (0,4 – 0,7 гол), масою гнізда на час відлучення у віці 28 діб (4,6 – 7,1 кг), СІВЯС (4,01 – 6,85 бала). Максимальний показник збереженості поросят до відлучення у віці28 діб (94,1 %) виявлено у свиноматок ІІІ піддослідної групи. Кількість достовірних коефіцієнтів парної кореляції між індексом адаптивно-продуктивних якостей Kh_2, тривалість життя, тривалість племінного використання та відтворювальними якостями свиноматок поєднання ½ велика біла × ½ ландрас дорівнює 50,0 %. Максимальну прибавку додаткової продукції одержано від свиноматок І піддослідної групи (Kh_2=70,19-119,57 бала). Вона становить +4,65 %, а її вартість дорівнює +240,12 грн. / гол / опорос. Критерієм відбору свиноматок з високими адаптивними і продуктивними якостями є тварини у яких індекс Kh_2 становить 70,19 і більше балів.

Ключові слова: *свиноматка, порода, поєднання, адаптивно-продуктивні якості,індекс, мінливість, кореляція, вартість додаткової продукції.*

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