

SECTION 8. AGRICULTURAL SCIENCES AND FOODSTUFFS

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BLUP INDEX: CRITERIA OF SELECTION OF HIGH PRODUCTIVITY SOWS AND ECONOMIC EVALUATION OF THEIR USE

Summary. *The paper presents the results of the study of indicators of the own productivity of repair pigs and reproductive qualities of sows of different intrabreed differentiation according to the BLUP index, as well as to determine the economic efficiency of the use and selection criteria of highly productive animals. It was established that repair pigs of large white breed by the age of reaching a live weight of 100 kg (days) and a fat thickness at the level of 6-7 thoracic vertebrae (mm) belong to the elite class. Sows of I experimental group are characterized by the maximum indicators of multifertility, milk yield, number of piglets at the time of weaning and weight of the nest at the time of weaning (BLUP index = 106.35-128.76 points). The index of M. D. Berezovsky in the animals of the specified group, is equal to 40.90 ± 0.511 points. The number of reliable correlations between the indicators of the reproductive qualities of the tested sows and the BLUP index (maternal line) is 83.33%; the relationship between the BLUP index (maternal line) and signs of own productivity is weak and unreliable ($r = -0.039 - +0.009$). The use of sows of high breeding value (I experimental group) provides additional production at the level of +7.70 %, and its cost is +300.53 UAN or +7.60 dollars per head / farrowing. The criterion for selecting highly productive animals of the controlled population is the value of the BLUP index at the level of 106.35-128.76 points.*

The theoretical basis for conducting research is the fundamental works of blighty and foreign scientists (Tsereniuk, Akimov, Babich, Kropivets-Domanska, 2021; Khalak, Gutiy, Bordun, 2020; Berezovsky, 1999; Grishina, Fesenko, 2015; Getya, Nagy, Berezovskyy., Kodak, Farkas, Szabu, 2010; Khalak, Gutyj, Stadnytska, Shuvar, Balkovskyyi, Korpita, Shuvar, Bordun, 2021; Kremez, Povod, Mikhalko, Susol, Tribirat, Onyshchenko, Kravchenko, Verbelchuk, Shchenbina, 2022; Kramarenko, Lugovy, Lykhach, Kramarenko, Lykhach, Slobodianyk, 2019; Khalak, Gutiy, 2020; Khalak, 2015; Martyniuk, Tsereniuk, Akimov, 2019; Vashchenko, Balatskyi, Pochernyaev, 2015; Koivula, Strandén, et al., 2012).

The purpose of the work is to investigate the indicators of own productivity of repair pigs and reproductive qualities of sows of different intrabreed differentiation according to the BLUP

(maternal line) index, as well as to determine the economic efficiency of use and criteria for selecting highly productive animals for further use in controlled populations.

Research materials and methods. The research was conducted in the research farm and laboratory of animal husbandry and fodder production of the Institute of Agriculture of the Northeast of the National Academy of Agrarian Sciences of 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 were repair pigs and sows of the large white breed. The BLUP (Best Linear Unbiased Prediction) index was calculated on the basis of the main institution (Institute of Pig Breeding and APV of the National Academy of Sciences) according to the general model of a single animal (Vashchenko, 2010; *Methodical recommendations for the collection of primary data of zootechnical accounting ...*, 2010). To measure the fat thickness, an ultrasonic device RENKO LEAN MEATER DIGITAL BACKFAT IDIC, S/N 46080, (USA) was used (Fig. 1).



Fig. 1. Device for measuring the thickness of lard in pigs RENKO CE (RENKO LEAN MEATER DIGITAL BACKFAT IDIC, S/N 46080)

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

$$I = B + (2 \times W) + (35 \times G)$$

where: *I* – index of M. D. Berezovsky, point; *B* – the number of piglets at the time of birth, head; *W* – the number of weaned piglets at the time of weaning, head; *G* – average daily growth of piglets before weaning, kg (Vashchenko, 2019).

The calculation of the cost of additional products (*Methodology for determining economic efficiency ...*, 1983) and biometric indicators (Kovalenko, Khalak, Nezhlukchenko, Papakina, 2010) was carried out according to generally accepted methods using the programmable module "Data Analysis" in Microsoft Excel.

Research results and their discussion. It was established that the age of reaching a live weight of 100 kg by repair pigs of the controlled population is 175.0 ± 1.06 days ($Cv=6.09\%$), the fat thickness at the level of the 6th–7th thoracic vertebra is 23.0 ± 0.15 mm ($Cv=6.76\%$), the fat thickness in the middle point of the back between the withers and the sacrum is 17.2 ± 0.15 mm

($Cv=9.05\%$), the fat thickness on the sacrum is 20.3 ± 0.12 mm ($Cv=6.22\%$), body length – 116.7 ± 0.18 cm ($Cv=1.63\%$). The duration of gestation of the sows being tested is 114.5 ± 0.15 head ($Cv=1.38\%$), multifertility – 11.6 ± 0.13 heads ($Cv=11.98\%$), high fertility – 1.40 ± 0.011 kg ($Cv=8.41\%$), evenness (homogeneity) index sow's nests by live weight of piglets at the time of their birth - 5.49 ± 0.073 points ($Cv=13.39\%$), milk yield - 54.0 ± 0.98 kg ($Cv=18.40\%$), age at the time of weaning - 32.0 ± 0.18 days ($Cv=5.68\%$), nest weight at the time of weaning – 76.7 ± 1.01 kg ($Cv=13.34\%$). The BLUP index (maternal line) in sows of the controlled population is equal to 106.28 ± 0.928 points ($Cv=8.78\%$), the indicator "preservation of piglets until weaning at the age of 28 days, %" ranges from 63 to 100 %.

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 animals of the I and II groups in terms of multifertility is equal to 1.5 piglets per farrowing ($td=6.52$, $P<0.001$), milk yield 13.4 kg ($td=7.88$, $P<0.001$), the number of piglets at the time of weaning - 1.0 head ($td=4.16$, $P<0.001$), the weight of the nest at the time of weaning at the age of 32 days - 10, 8 kg ($td=6.14$, $P<0.001$), M. D. Berezovsky's index – 4.33 points ($td=6.96$, $P<0.001$) (Table 1).

In terms of high fertility, the difference between sows is 0.04 kg in favor of II group animals ($td=1.73$, $P>0.05$). The maximum rate of survival of piglets before weaning ($92.7\pm 0.67\%$) was also found in the animals of the II experimental group.

The coefficient of variation ($Cv, \%$) of the reproductive qualities of sows of the large white breed of different breeding value, evaluated according to the BLUP index (maternal line), ranges from 8.0 ± 0.862 to $16.27\pm 1.510\%$.

Table 1

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

Indicators, units of measurement	Biometric indicators	Gradations of the BLUP index (maternal line)	
		106,35-128,76	90,36-106,12
		group	
		I	II
Multifertility, head	n	43	58
	$X\pm Sx$	12,5 \pm 0,18	11,0 \pm 0,15
	$Cv\pm Scv, \%$	9,4 \pm 1,014	10,6 \pm 0,984
Fertility kg	$X\pm Sx$	1,40 \pm 0,017	1,44 \pm 0,0163
	$Cv\pm Scv, \%$	8,0 \pm 0,862	9,4 \pm 0,872
Milk content, kg	$X\pm Sx$	62,8 \pm 1,35	49,4 \pm 1,05
	$Cv\pm Scv, \%$	14,71 \pm 1,586	16,27 \pm 1,510
Number of piglets at the time of weaning, head	$X\pm Sx$	11,2 \pm 0,18	10,2 \pm 0,17
	$Cv\pm Scv, \%$	11,57 \pm 1,248	13,96 \pm 1,296
Weight of the nest at the time of weaning, kg	$X\pm Sx$	83,1 \pm 1,38	72,3 \pm 1,10
	$Cv\pm Scv, \%$	10,94 \pm 1,180	11,64 \pm 1,080
Preservation of piglets until weaning, %.	$X\pm Sx$	89,6 \pm 0,92	92,7 \pm 0,67
Index of M. D. Berezovsky, point	lim	34,33-50,58	30,08-48,27
	$X\pm Sx$	40,90 \pm 0,511	36,57 \pm 0,467
	$Cv\pm Scv, \%$	8,20 \pm 0,884	9,71 \pm 0,901

The results of the calculation of pairwise correlation coefficients between the characteristics of own productivity, reproductive qualities and the BLUP index (maternal line) in pigs of the large white breed are shown in Table 2.

Table 2

Coefficient of paired correlation between signs of own productivity of repair pigs, reproductive qualities of sows and integrated indicators

Sign		Biometric indicators	
<i>x</i>	<i>y</i>	<i>r ± Sr</i>	<i>tr</i>
BLUP index (maternal line), point	1	-0,013±0,0857	0,15
	2	0,007±0,0858	0,08
	3	0,009±0,0858	0,11
	4	-0,039±0,0856	-0,46
	5	-0,037±0,0856	-0,43
	6	0,704±0,0433***	16,28
	7	-0,215±0,0818**	2,62
	8	0,644±0,0502***	12,82
	9	0,654±0,0491***	13,31
	10	0,622±0,0526***	11,83
	11	-0,066±0,0854	0,77
	12	0,693±0,0446***	15,55

Notes: 1 - age of reaching 100 kg live weight, days; 2 - body length, cm; 3 – fat thickness at the level of 6–7 thoracic vertebrae, mm; 4 – bacon thickness on sacrum, mm; 5 - fat thickness in the middle point of the back, mm; 6 - fertility, head; 7 – high fertility, kg; 8 – milk yield, kg; 9 – the number of piglets at the time of weaning, head; 10 – nest weight at the time of weaning at the age of 28 days, kg; 11 – preservation, %; 12 – M.D. Berezovsky's index, point; *** - $P < 0.001$

Studies have shown that the correlation coefficient between the BLUP index (maternal line), signs of own productivity of repair pigs and reproductive qualities of sows ranges from -0.215 ± 0.0818 ($t_r = 2.62$) to $+0.704 \pm 0.0433$ ($t_r = 16.28$).

Reliable relationships were established between the following pairs of traits: BLUP index (maternal line) × fertility ($r = +0.704$; $t_r = 16.28$), BLUP index (maternal line) × large fertility ($r = -0.215$; $t_r = 2.62$), BLUP index (maternal line) × milk yield ($r = +0.644$; $t_r = 12.82$), BLUP index (maternal line) × number of piglets at weaning time ($r = +0.654$; $t_r = 13.31$), BLUP index (maternal line) × weight of the nest at the time of weaning at the age of 28 days ($r = +0.622$; $t_r = 11.83$). The correlation between the BLUP index (maternal line) and MD Berezovsky's index is highly reliable and is equal to $r = +0.693$ ($t_r = 15.55$).

The results of calculating the economic efficiency of using sows of different breeding value, evaluated by the BLUP method (maternal line) are shown in Table 3.

Table 3

Economic efficiency of using sows of different breeding value, evaluated by the BLUP method (maternal line)

Group	n	Weight of the nest at the time of weaning, kg	Addition of additional products %	Cost of additional products, UAN / USD / head
Total sample	101	76,7±1,01	-	-
II	58	72,3±1,10	-5,73	-223,64 / -5,67
I	43	83,1±1,38	+7,70	+300,53 / +7,60

Note: * - the average selling price of young pigs at the time of the experimental part of the research was 67.85 UAN or 1.71 USD per 1 kg of live weight

Calculations of the economic efficiency of the research results indicate that the maximum increase in additional production was obtained from sows of the 1st experimental group (BLUP index = 106.35-128.76 points) - +7.70 %, and its value is +300.53 UAN or +7.60 USD / farrowing.

Conclusions:

1. It was established that repair pigs of a large white breed by the age of reaching a live weight of 100 kg (days) and a fat thickness at the level of 6-7 thoracic vertebrae (mm) belong to the elite class.

2. The maximum indicators of multifertility (12.5 ± 0.18 heads), milk yield (62.8 ± 1.35 kg), number of piglets at the time of weaning (11.2 ± 0.18 heads) and nest weight at the time of weaning (83.1 ± 1.38 kg) are characterized by sows of the I experimental group (BLUP index = 106.35-128.76 points); the index of M.D. Berezovsky is 40.90 ± 0.511 points.

3. The coefficient of variation (Cv, %) of the reproductive qualities of sows of the large white breed of different breeding value, evaluated according to the BLUP index (maternal line) ranges from 8.0 ± 0.862 to 16.27 ± 1.510 %.

4. The number of reliable correlations between the indicators of the reproductive qualities of the sows being tested and the BLUP index (maternal line) is 83.33 %; the relationship between the BLUP index (maternal line) and signs of own productivity is weak and unreliable ($r = -0.039 - +0.009$).

5. The use of sows of high breeding value (I experimental group) provides additional production at the level of +7.70 %, and its cost is +300.53 UAN or +7.60 dollars per head / farrowing

6. The BLUP index value at the level of 106.35-128.76 points is the criterion for selecting highly productive animals of the controlled population.

References:

1. Tserenyuk, O. M., Akimov, O. V., & Babich, M., Kropivets'-Domans'ka K. (2021). Analiz vidtvornykh yakostey svyney porody landras ta uel's v sub'yektakh plemynnoi spravy Ukrayiny. [Analysis of the reproductive qualities of pigs of the landrace and Welsh breeds in the subjects of the breeding case of Ukraine]. *Naukovo-tekhnichnyy byuletyn Instytutu tvarynnyctva NAAN*. 125, 227–237. <https://doi.org/10.32900/2312-8402-2021-125-227-237> [in Ukrainian].
2. Khalak, V. I., Hutyy, B. V., & Bordun, O. M. (2020). Innovatsiyni metody otsinky svynomatok za pokaznykamy vidtvoryuval'nykh yakostey ta kryteriyi yikh vidboru za deyakomy polikomponentnyy matematychnyy modelyamy. [Innovative methods of evaluation of sows by indicators of reproductive qualities and criteria for their selection according to some multicomponent mathematical models]. *NV LNU veterynarnoyi medytsyny ta biotekhnolohiy. Seriya: Sil's'kohospodars'ki nauky*. 24(96), 70–77. <https://doi.org/10.32718/nvlvet-a9609> [in Ukrainian].
3. Berezovskyy, M. D. (1999). Stan i perspektyvy selektsiyi svyney velykoyi biloyi porody v Ukrayini [Status and prospects of large white breed pig breeding in Ukraine]. *Visnyk ahrarnoyi nauky*. 10, 49–52 [in Ukrainian].
4. Hryshyna, L. P., Fesenko, O. H. (2015). Efektyvnist' vykorystannya spetsializovanoho typu svyney za skhreshchuvannya ta hibrydzatsiyi [Effectiveness of using a specialized type of pigs for crossbreeding and hybridization]. *Visnyk ahrarnoyi nauky Prychornomorya: mizhvidom. temat. nauk. zb.*, 2(84), v 2, 40–47. [in Ukrainian].
5. Getya, A., Nagy, I., Berezovskyy, M., & Kodak, O., Farkas, J., Szaby, Cs. Estimation of genetic trend for the backfat 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, 2010. P. 214.
6. Khalak, V., Gutyy, B., Stadnytska, O., Shuvar, I., Balkovskyy, V., Korpita, H., Shuvar, A., Bordun, O. Breeding value and productivity of sows of the Large White breed. *Ukrainian Journal of Ecology*, 2021. 11 (1). P. 319–324. https://doi.org/10.15421/2021_48
7. Kremez', M. I., Povod, M. H., & Mykhalko O. H., Susol, R. L., Trybrat, R. O., Onyshchenko, L. V., Kravchenko, O. O., Verbel'chuk, T. V., O., Shchenbyna, O. V. (2022). Vidtvoryuval'ni oznaky svyney irlands'koyi selektsiyi ta proyav riznykh form heterozyosu za riznykh metodiv rozvedennya v suchasnykh umovakh promyslovo-ho vyrobnyctva svynyny [Reproductive characteristics of pigs of

- Irish breeding and manifestation of different forms of heterosis under different methods of breeding in modern conditions of industrial pork production]. *NV LNU veterinaryarnoyi medytsyny ta biotekhnolohiy. Seriya: Sil's'kohospodars'ki nauky*, 24(96), 78–88. <https://doi.org/10.32718/nvlveta9610> [in Ukrainian].
8. Kramarenko, S. S., Luhovyy, S. I., & Lykhach, A. V., Kramarenko, O. S., Lykhach, V. Ya., Slobodyanyk, A. A. (2019). Vplyv henetychnykh ta nehenetychnykh faktoriv na vidtvoryuval'ni oznaky svynomatok ukrayins'koyi m'yasnoyi porody [The influence of genetic and non-genetic factors on the reproductive characteristics of sows of the Ukrainian of clear breed]. *NV LNU veterinaryarnoyi medytsyny ta biotekhnolohiy. Seriya: Sil's'kohospodars'ki nauky*. 21(90), 3–8. <https://doi.org/10.32718/nvlvet-a9001> [in Ukrainian].
 9. Khalak, V. I., Hutyy, B. V. (2020). Oznaky vidtvoryuval'nykh yakostey svynomatok riznykh typiv adaptatsiyi, yikh minlyvist' ta korelyatsiynyy zv'yazok [Signs of reproductive qualities of sows of different types of adaptation, their variability and correlation]. *NV LNU veterinaryarnoyi medytsyny ta biotekhnolohiy. Seriya: Sil's'kohospodars'ki nauky*. 22(92), 35–41. <https://doi.org/10.32718/nvlvet-a9207> [in Ukrainian].
 10. Khalak V. I. (2015). Matematychni modeli vyznachennya vyrivnyanosti hnizda svynomatok ta yikh zootekhnichna otsinka [Mathematical models for determining the alignment of the nest of sows and their zootechnical assessment] *Bioresursy i pryrodokorystuvannya*. 7 (1-2), 103–109 [in Ukrainian].
 11. Martynyuk, I. M., Tserenyuk, & O. M., Akimov, O. V. (2019). Zaplidnenist' ta bahatoplidnist' svynomatok zalezho vid kratnosti osimeninnya u rizni pory roku. [Fertility and multiple fertility of sows depending on the frequency of insemination in different seasons]. *Naukovo-tekhnichnyy byuleten' Instytutu tvarynnystva NAAN*, 121, 156–162. <https://doi.org/10.32900/2312-8402-2019-121-156-16> [in Ukrainian].
 12. Vashchenko, P. A., Balatskiy, V. N., & Pochernyayev, K. F. (2015). Ispol'zovaniye modeli BLUP s vklyucheniyyem DNK-markerov dlya otsenki sviney [Using the BLUP model with the inclusion of DNA markers to assess pigs]. *Zootekhnicheskaya nauka Belarusi: Sbornik nauchnykh trudov*. 50 (1), 43–5 [in Russian].
 13. 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) / M. Koivula, I. Strandén, G. Su [et al.] // *Journal of dairy science*. 2012. Vol. 95 (7). P. 4065–4073.
 14. Vashchenko, P. A. (2010). Vyznachennya pleminnoyi tsinnosti svynei riznymi metodamy [Determining the breeding value of pigs by different methods] *Visnyk ahrarnoyi nauky Prychornomor'ya*, 1 (52), v. 2, 76–79. [in Ukrainian].
 15. Institute of Swine Industry named after O. V. Kvasnytskyi of NAAS (2010). *Metodychni rekomendatsiyi shchodo zboru pervynnykh danykh zootekhnichnoho obliku dlya vyznachennya pleminnoyi tsinnosti svynei v avtomatyzovanomu rezhymi* [Methodological recommendations for the collection of primary zootechnical accounting data for determining the breeding value of pigs in an automated mode]: Poltava: 12 p. [in Ukrainian].
 16. Vashchenko, P. A. (2019). *Prohnozuvannya pleminnoyi tsinnosti svynei na osnovi liniynykh modeley selektsiynykh indeksiv ta DNK-markeriv*. Forecasting the breeding value of pigs based on linear models of selection indices and DNA markers: (Extended abstract of doctor's thesis). Mykolayiv. nats. ahrar. un-t. Mykolayiv [in Ukrainian].
 17. *Metodika opredeleniya ekonomicheskoy effektivnosti ispol'zovaniya v sel'skom khozyaystve rezul'tatov nauchno-issledovatel'skikh rabot, novoy tekhnologii, izobreteniy i ratsionalizatorskikh predlozheniy* (1983). [Methodology for determining the economic efficiency of the use in agriculture of the results of scientific research, new technology, inventions and rationalization proposals]. 149 p. [in Russian].
 18. Kovalenko, V. P., Khalak, V. I., & Nezhlukchenko, T. I., Papakina, N. S. (2010). Biometrychnyy analiz minlyvosti oznak sil's'kohospodars'kykh tvaryn i ptytsi [Biometric analysis of the variability of traits of agricultural animals and poultry]. Kherson: Oldi, 160 p. [in Ukrainian].