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ESTIMATION OF GENETIC VARIABILITY OF FERTILITY TRAITS OF PIGS[1]

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Contents: Knowledge of heritability of production traits in pigs is of great importance because of the evaluation of the success of selection and choice of adequate method of selection. Objective of this paper was to determined the heritability coefficients of fertility traits in pigs of Swedish Landrace breed as well as change of values of mentioned parameters depending on the introduction of results of realzied fertility in the second and third farrowing into analysis.

Heritabilities of observed traits were determined using the method of intra-class correlation of half siblings (half sisters) on sire side. In the model for analysis, beside the random effect of sire, also fixed model of the order of farrowing was included when analysis included fertility realized in the second and third farrowing. Because of the absence of other factors in the model, due to the limitations of the used programme, some traits were corrected for effects which dominantly cuased their variations. Investigation included 926 first, 1598 first two and 2115 first three farrowings. Heritability of number of live born piglets, total born and reared piglets per litter as well as mass of litter at weaning were determined in intervals from 0.083 to 0.126, 0.097 to 0.131, 0.068 to 0.090 and 0.164 to 0.209, respectively.

Key words: pigs, fertility traits, intra class correlation, heritability.

Introduction

Improving of fertility traits of pigs is in the centre of attention of breeders as well as researchers engaged in the field of pig production. Prerequisite for carrying out of selection is knowledge of the genetic variability of fertility. This knowledge is of great importance for the determination of optimal method of selection that will be used in specific conditions, as well as because of the direct dependence of the selection effects on the level of its expression.

Fertility of pigs varies under the influence of different parameters of genetic and paragenetic nature. Of great importance is as accurate as possible determination of environmental factors that can influence the achieved fertility of pigs *(Petrović Milica et al., 1998)*. This is of greatest importance in case of determination of genetic parameters, in order to make correction of phenotypic values of fertility traits in relation to the effect of known factors and increase their accuracy, by using adequate mathematical-statistical procedures. This is also confirmed by fact, already presenting a rule, those fertility traits, and especially litter size traits, are characterized by low heritability *(Wolfova Marie and Wolf, 1997)*.

Objective of this paper was to determine genetic variability of fertility traits in single population of Swedish Landrace sows in Serbia. Genetic variability was investigated based on realized sow fertility in the first parity, the first two parities and first three parities.

Material and Method

Genetic variability of fertility traits was determined in Swedish Landrace sows on one farm in Serbia. Research included 926 sows and 926 of their first parities, 1598 of the first two parities and 2115 of first three parities. Sows originated from 43 sires.

Data was processed by method of Least squares – programme package LSMLMW and MIXMDL *(Harvey, 1990)*.

Following fertility traits were analysed: number of born alive piglets (NBA), number of total born piglets (TNB), corrected number of weaned piglets (CNW) and corrected liter weight on weaning (CLWW).

Heritability coefficients of selected traits of fertility of sows were determined by method of intraclass correlation of groups of sisters with the same sire. Genetic variability was investigated using the following mixed model of the least squares method:

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$$Y_{ijk} = \mu + S_i + P_j{}^* + e_{ijk}$$

where:
Y_{ijk} – expression of the trait in k-individual animal, originating from i-sire, j-parity,
μ – general average,
S_i – random effect of i-sire (i=1,...,43),
P_j – fixed influence of j-parity (j=1,2 or j=1,2,3),
e_{ijk} – random error.
* not used in determination of genetic variability of investigated traits in first parity.

Due to the specificity of the structure of data as well as limitations of the used software package, no other fixed or regression factors could be included into models for determination of genetic variability except ones presented in this paper. This induced the need to correct certain traits in regard to the influence of factors that are dominantly causing their variation, that is under whose direct (linear) effect the expression of mentioned traits is depending. In order to obtain more objective evaluation of the heritability coefficient for litter size and weight at weaning, correction of mentioned parameters was carried out using the method of base indexing. Number of weaned piglets was corrected (CNW) in regard to the average litter size raised by sows (CLS), and weight of litter at weaning was corrected (CLWW) for average number of weaned piglets and average duration of lactation (NW and L).

Results of investigation and discussion

In table 1, heritability of the traits of litter size and weight at birth and weaning for first three parities is presented.

Table 1. Heritability coefficients and its errors of fertility traits determined based on different scope of used data

Traits[2]	$h^2 \pm S.E._{(h^2)}$		
	I[1]	I + II	I + II + III
NBA	0.083 ± 0.058	0.126 ± 0.049	0.110 ± 0.041
TNB	0.097 ± 0.061	0.131 ± 0.050	0.116 ± 0.042
CNW	0.068 ± 0.055	0.090 ± 0.042	0.068 ± 0.032
CLWW	0.164 ± 0.073	0.180 ± 0.060	0.209 ± 0.059

[1]I – first parity; I + II – first two parities; I + II + III – first three parities.
[2]NBA: number of born alive piglets; TNB: total number of born piglets; CNW: corrected number of weaned piglets; CLWW: corrected litter weight on weaning.

Number of live born piglets in litters of first farrowing sows varied under the influence of hereditary basis by 8.3%, which indicates that variation of this trait was mostly influenced by different factors of environment. Approximately similar values in regard to the variation of nba in litters of first farrowing sows under the influence of hereditary basis were obtained by *Roehe and Kennedy (1995)*. Higher hereditary dependence of the expression of mentioned trait in first farrowing was determined by *Petrović Milica and Radojković (1992)*, *Irgang et al. (1994)*, and *Tölle et al. (1998)*, whereas *Taubert et al. (1998)* determined lower value of this parameter.

Introduction of results of achieved fertility in second parity into analysis induced determination of higher heritability values as well as decrease of error (0.126 ± 0.049). Same conclusion referring to the effect of use of larger scope of data on parameter value was made by *Kosovac Olga and Petrović Milica (1994)*. Established value of observed parameter was higher in mentioned investigation.

Heritability of NBA calculated based on fertility results for first three parities together was 0.110, and was higher compared to the value of same parameter determined based on fertility in first parity, but lower than the same parameter determined based on fertility in first two parities. Heritability error was smaller compared to the preceding ones. Higher values of h^2 were determined based on fertility in first three parities were also observed and presented by *Roehe and Kennedy (1995)*, *Siewerdt et al. (1995)*, *Huang and Lee*

(1996) and *Kim et al. (1998)*. Contrary to mentioned investigations are results obtained by another group of authors demonstrating lower values of this parameter (*Babot et al., 1994*, *Bidanel and Ducos, 1994*, *Choi et al., 1995*, *Boesch et al., 1998* and *Petrović Milica et al., 1998*).

Heritability of total litter size at birth (TNB) varied in the interval from 0.97 (first parity) to 0.131 (first two parities). In regard to the effect of increased scope of data used in analysis on the value of heritability coefficient and its error, same conclusions can be made as for NBA which is understandable due to the already very well established correlation of these traits. The same can be applied for established values of this parameter in comparison to values in investigation mentioned in case of NBA.

Size of litter at weaning, corrected as explained in the text (cNW), varied under the influence of genetic factors from 6.8% (first parity) to 9% (first two parities). Increase of the scope of data used in the analysis influenced the value of h^2 and error on identical way as for previously explained traits. Higher heritability values for litter size at weaning were also presented by large group of authors (*Bidanel and Ducos, 1994*, *Choi et al., 1995, Roehe and Kennedy, 1995, Siewerdt et al., 1995, Huang and Lee, 1996, Kim et al., 1998* and *Petrović Milica et al., 1998*), whereas lower values were presented by *Milagres et al. (1981)* and *Johansson (1983)*.

Introduction of results for achieved fertility in second and third parity into analysis induced increase of determined heritability values for clww, also increase of accuracy of this parameter. Heritability of this trait was the highest when calculated based on results for first three parities - 20.9%. Lower values of heritability for this trait, when analysis included first three or more parities, were determined by numerous researchers (*Kim et al., 1988*, *Kosovac Olga et al., 1994, Siewerdt et al., 1995, Huang and Lee, 1996 and Kim et al., 1998)*. Higher correlation of the variability of this trait and heritability factors was determined by *Lewczuk et al. (1991)* and *Ferraz and Johnson (1993)*.

Introduction of genetic variability of achieved fertility results in third parity into analysis didn't induce the determination of higher heritability for litter size traits (NBA, TNB and NW). This is contrary to the effects occurring when achieved fertility in second parity was included into analysis. Reason for this could be in the fact that subsequent to the second parity females that did not satisfy determined selection criteria or experienced problems in reproduction were excluded from the further reproduction. Criteria for culling of female breeding animals after first parity are lower considering that in this age females are still growing and developing and they should be given another chance to fully demonstrate and express their reproduction potential. Such approach results in increase of additive genetic variance of observed traits when it is determined based on achieved fertility in first two parities. Contrary to this, carrying out of selection of female breeding animals after second parity reduces genetic variability resulting in lower values of determined heritabilities.

Conclusion

Increase of the scope of data used in analysis of genetic variability of observed traits induced determination of higher values of heritability coefficients and higher accuracy of these parameters, when achieved results of fertility in second parity were included into analysis. However, this was not the case when results of fertility realized in the third parity were included into analysis (except for cLWW). Heritability coefficients for NBA, TNB, cNW and cLWW in first, first two and first three parities were in the interval from 0.083 - 0.126, 0.097 - 0.131, 0.068 - 0.090 and 0.164 - 0.209, respectively.

OCENA GENETSKE VARIJABILNOSTI OSOBINA PLODNOSTI SVINJA

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Rezime

Poznavanje naslednosti proizvodnih osobina svinja je od velikog značaja, kako zbog procene efekata selekcije, tako i zbog izbora adekvatnog metoda selekcije. cilj ovoga rada je bio da se utvrde koeficijenti naslednosti osobina plodnosti svinja rase švedski landras, kao i promena vrednosti pomenutih parametara u zavisnosti od uključivanja u analizu rezultata ostvarene plodnosti u drugom i trećem prašenju po redu.

Heritabiliteti posmatranih osobina utvrđeni su metodom intraklasne korelacije polusrodnika (polusestara) po ocu. u model za analizu je, pored slučajnog uticaja očeva, bio uključen i fiksni uticaj redosleda prašenja kada je analizom bila obuhvaćena i plodnost ostvarena u drugom i trećem prašenju. nemogućnost uključivanja drugih faktora u model, zbog ograničenja korišćenog programskog paketa, uslovila je neophodnost korekcije nekih osobina na uticaje koji su dominantno dovodili do njihovog variranja. istraživanjem je bilo obuhvaćeno 926 prvih, 1598 prvih dva kao i 2115 prvih tri prašenja. heritabiliteti broja živorođene, ukupnorođene i odgajene prasadi po leglu kao i mase legla pri zalučenju kretali su se u intervalima od 0.083 do 0.126, 0.097 do 0.131, 0.068 do 0.090 i 0.164 do 0.209, respektivno.

Ključne reči: svinje, osobine plodnosti, intraklasna korelacija, heritabilitet

References

1. BABOT D., NOGUERA J.L., ALFONSO L., ESTANY J. (1994): Influence of managment effects and comparison group size on the prediction of breeding values for litter size in pigs. Proceedings of the 5th World Congres on Genetics Applied to Livestock Production, Canada. vol. 17, 351-354.
2. BIDANEL J.P., DUCOS A. (1994): Utilisation du blup modele animal pour levaluation genetique des porcs de race large white it landrace francais sur la proloficite. Journees de la Recherce Porcine en France, 26, 321-326. (abstrakt)
3. BOESCH M., ROEHE R., LOOFT H., KALM E. (1998): Estimation of the genetic association between purebred and crossbred performance for litter size in pigs. 6th World Congress on Genetics Applied to Livestock Production, Armidale, Australia, 11-16 January, 1998. vol. 23, 595-598.
4. CHOI Y.L., JEON G.J., CHOI K.S., KIM S.H., JUNG Y.C. (1995): Estimation of genetic parameters for reproductive traits in landrace. RDA Journal of Agricultural Science, Livestock, 37, 2, 479-483.
5. FERRAZ J.B.S., JOHNSON R.K. (1993): Animal model estimation of genetic parameters and response to selection for litter size and weight, growth, and backfat in closed seedstock populations of Large White and Landrace swine. Journal of Animal Science, 71, 4, 850-858.
6. HARVEY W.R. (1990): User's guide for LSMLMW and MIXMDL, PC-2 version.
7. HUANG Y.H., LEE Y.P. (1996): "Genetic study on reproductive performance of purebred pigs." Journal of the Chinese Society of Animal Science, 25, 4, 391-402. (abstract)
8. IRGANG R., FAVERO J.A., KENNEDY B.W. (1994): Genetic parameters for litter size of different parities in Duroc, Landrace, and Large White sows. Journal of Animal Science, 72, 2237-2246.
9. JOHANSSON K. (1983): Avel for fruktsamhet ett olonsamt arbete. Svinskotsel, 73, 3, 23.
10. KIM J.B., CHUNG H.W., PARK Y.J. (1988): "Heritabilites and genetic correlations between litter size and litter weight in swine." Korean Journal of Animal Sciences, 30, 10, 596-599.
11. KIM M.J., KIM S.D., PARK B.H., HAN S.U., SANG B.C. (1998): Estimation of genetic parameters and genetic trends in litter size and litter weight of swine. 8th World Conference of Animal Production, Seul, Korea, June 28 - July 4, 1998. Contributed papers, vol. i, 676-677.
12. KOSOVAC OLGA, PETROVIĆ MILICA (1994): Heritability of reproductive traits of purebred sows and f1 generation. Review of Research Work at Faculty of Agriculture, 39, 2, 19-23.
13. KOSOVAC OLGA, VIDOVIĆ V., PETROVIĆ MILICA (1994): Fenotipski parametri reproduktivnih osobina krmača različitih genotipova u prva dva prašenja. Biotehnologija u stočarstvu, 10, 3-4, 53-56.
14. LEWCZUK A., JANISZEWSKA M., GRUDNIEWSKA B., BOCHNO R. (1991): Odziedziczalnosc i powtarzalnosc cech dzialnosci rozrodczej loch hodowanych na terenie dzialalnosci oshz w olsztynie. Acta Academiae Agriculturae ac Technicae Olstensis, Zootehnica, 34, 23-32.
15. MILAGRES J.C., FEDALTO L.M., SILVA M. DE A.E., PEREIRA J.A.A. (1981): Fontes de variacao de tamanhos e pesos de leitegados, do nascimento aos 21 dias de idade, nas racas Duroc, Landrace e Large White. I Tamanho da leitegada. Revista da Sociedade Brasileira de Zootehnica, 10, 4, 653-671. (abstract)
16. PETROVIĆ MILICA, RADOJKOVIĆ D. (1992): Ocena priplodne vrednosti nerastova primenom mešovitog modela. Biotehnologija u stočarstvu, 8, 5-6, 209-214.
17. PETROVIĆ MILICA, TEODOROVIĆ M., RADOJKOVIĆ D., KOSOVAC OLGA. (1998): Determinacija faktora koji utiču na variranje reproduktivnih osobina krmača. Savremena poljoprivreda, 47, 5-6, 121-126.

18. ROEHE R., KENNEDY B.W. (1995): Estimation of genetic parameters for litter size in Canadian Yorkshire and Landrace swine with each parity of farrowing treated as a different trait. Journal of Animal Science, 73, 2959-2970.
19. SIEWERDT F., CARDELLINO R.A., ROSA V.C. DA (1995): "Genetic parameters of litter traits in three pig breeds in southern Brasil." Revista Brasileira de Genetica, 18, 2, 199-205. (abstract)
20. TAUBERT H., BRANDT H., GLODEK P. (1998): Estimation of genetic parameters for farrowing traits in purebred and crossbred sows and estimation of their genetic relationships. 6th World Congress on Genetics Applied to Livestock Production, Armidale, Australia, 11-16 January, 1998. vol. 23, 579-582.
21. TöLLE VON K. H., THOLEN E., TRAPPMAN W., STORK F.J. (1998): Moglichkeiten der Zuchtwertschatzung fur Reproduktionsmerkmale beim Schwein am Beispiel eines Schweinezuchterverbandes. Zuchtungskunde, 70, 5, 351-361.
22. WOLFOVA MARIE, WOLF J. (1997): Aktualni problemy v odhadu plemennych hodnot pro reprodukčni ukazatele u prasat. Živočišna vyroba, 42, 12, 553-561.